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CORN-GROWING IN SCOTLAND.

Sir Henry Rew, K.C.B.

The area under corn crops in Scotland as returned in June last was 1,134,864 acres, occupying 35 per cent. of the arable land. This includes rye and mixed grain. If the definition of corn be confined to wheat, barley and oats the proportion would be 34·5 per cent. In England and Wales at the same date wheat, barley and oats occupied, collectively, nearly 44 per cent. of the arable land, and in that case also the inclusion of rye (much of which is cut green) and mixed corn would make little difference.

So wide a difference in the relative position of corn-growing within the same island is noteworthy, but still greater divergencies are apparent on a survey of other countries. Without going beyond Europe we find that the proportion of corn crops to arable land ranges from 90 per cent. in Rumania, 72 per cent. in Poland (in both cases, however, excluding bare fallow) and 68 per cent. in Hungary, to 26 per cent. in Norway and the Irish Free State.

Fifty years ago corn crops in Scotland occupied slightly more than 38 per cent. of the arable land. The arable area has been reduced by about 10 per cent., while the area under corn crops has diminished by about 17 per cent. During the same period in England and Wales the arable area has decreased 28 per cent. and the area under corn crops by 30 per cent. Relatively therefore corn-growing has declined in Scotland rather more than in England and Wales during the last half century.

Of the acreage under corn crops in Scotland 82 per cent. is devoted to oats, 14 per cent. to barley and only 4 per cent. to wheat. Production per acre is in inverse ratio to area, wheat yielding 22·3 cwts., barley 17·8 cwts. and oats 15·5 cwts. On the basis of quantity, therefore, oats represent 79 per cent., barley 15 per cent. and wheat 6 per cent. of the total corn grown in 1925.

Fifty years ago oats occupied 75 per cent. of the corn area, barley 19 per cent. and wheat 6 per cent.

The generalisation from these figures is that corn-growing has

declined in Scotland as well as in England, and that oats have become still more predominantly the principal corn crop. The tendency has been the same on both sides of the Border, but it has been somewhat less accentuated in the North than in the South.

The alterations in the relative positions of the three cereals during the past half century may be conveniently shown in tabular form by a comparison of the acreage in 1881 and 1925 respectively. The figures represent thousands of acres

Crops.	England and Wales		Scotland.	
	1881.	1925.	1881.	1925
Wheat	2731	1499	75	48
Barley	2172	1319	271	153
Oats	1870	1867	1031	931

It is commonly assumed that Scotland has been faithful to the plough and that the reduction of the arable area which has been so marked in England has not taken place in Scotland. This is not literally accurate, though the statement approximately represents the facts. It is the more significant in view of the fact that Scotland has always—so far at least as records are available—been distinguished as a country of arable farming. Fifty years ago just three-fourths of the farmed land was under the plough, and to-day the proportion is 70 per cent. as compared with 35 per cent. in England and Wales. With the exceptions, possibly, of Denmark and Belgium, no European country has so high a proportion of its agricultural land in arable cultivation as Scotland.

The explanation usually offered of the retention of land under the plough, combined with a decline of corn growing, is an increased tendency to extend the duration of rotation grasses, in other words to leave the temporary leys for several years. It is true that in Scotland farming practice tends much more in that direction than in England. This is evident from the returns, which show that whereas 24 per cent. of the arable land south of the Border is in temporary grass, the proportion in Scotland is 42 per cent. But the returns do not show any marked change of practice in this respect. Fifty years ago the leys occupied 41 per cent. of the arable land. At the beginning of the century—i.e. in 1901—the proportion rose to 46 per cent., but it has since declined and in the present year, as already stated, it is 42 per cent.

The cause of any general change in farm practice may be first sought, and is sometimes found, in the markets. The course of corn prices is indicated in the following table compiled from a valuable series of index numbers recently published by the Ministry of Agriculture in a Report on the Stabilisation of Agricultural Prices. Taking the years 1876-8 as the base, the index numbers for wheat, barley and oats respectively for the triennial periods named were as follows:—

	Wheat.	*Barley.*	*Oats.*
1871–3	109	99	99
1881–3	88	83	87
1891–3	63	69	79
1901–3	55	64	75
1911–3	66	74	80
1921–3	108	110	122

During the whole period the index number for oats never fell below 60 and only six times below 70, while that for wheat fell twelve times below 60 and twice below 50. It is evident that oats better maintained their market value through the changes of price-level, in other words were more stable, than wheat. This is the more noteworthy in view of the fact that while the demand for wheat is probably more stable than that for any other commodity and increases steadily with the increase of population, the demand for oats might be expected to fall off as their chief consumers, horses, are replaced by motor vehicles.

In England and Wales the deduction to be made from the secular movements which the statistics reveal is fairly clear. Corn is there evidently giving way to stock, and the production of meat and milk is becoming the predominant object. The arable farmer is tending to rely on corn not as a primary product for direct sale, but as the raw material for the manufacture of milk and meat. It may be surmised that a similar tendency is to be traced in Scotland. But a surmise is not statistical evidence. Indeed the function of historical statistics is not so much to enunciate dogmatic statements but rather to put conundrums to the practical farmer. The figures cited herein suggest that, if a long view be taken, the position of corn-growing in Scottish Agriculture is slowly, almost imperceptibly, changing. If this is the fact the explanation is, as already remarked, not obvious from the statistical record, and the search for it must be remitted by the statistician to the practical farmer.

THE PRODUCTION OF BABY BEEF IN NORTHERN IRELAND.

Professor G. S. ROBERTSON, D.Sc., F.I.C., Belfast.

THE object of this article is to give an account of the development of the work on Baby Beef in Northern Ireland, with particular reference to its application in practice. It is one thing to demonstrate a problem experimentally and another to induce the practical farmer to put those results into everyday practice. An account of this work may, it is hoped, be of interest and perhaps of some service to farmers in those parts of Scotland where conditions are not dissimilar from those of Northern Ireland.

The production of prime beef has hitherto played a very small part in the development of agriculture in Northern Ireland. Distance from big markets, the absence of a demand in local towns for prime beef, together with the fact that the purchase of concentrated feeding stuff appears to the small farmers of the province to involve a greater capital outlay than they can afford, have all contributed to make Northern Ireland a store-rearing country.

Although store-rearing is the main feature of the cattle industry of Northern Ireland, there are farmers in the neighbourhood of the larger towns who produce stall-fed beef of "first" quality, if not of "prime" quality. Moreover, numbers of cattle leave the farms in July, August and September as grass beef. As a rule, however, the animals which leave the farm whether as grass or stall-fed beef intended for the butcher in Belfast, Glasgow or Liverpool, are usually about 2½ to 3 years old and frequently older.

The policy of store-rearing has not been without its challengers. There have been many who have argued that, if it paid the Scottish and English farmers to buy Irish stores and fatten them for prime beef, it must surely be to the further advantage of the Irish farmers to finish the process themselves. Be that as it may, the fact remains that the Irish farmer has hitherto found the "store" trade a profitable one, and has shown no marked disposition to question its economic soundness. As a cattle rearer the Irish farmer enjoys several important advantages. As a rule he has grass later in the autumn and frequently earlier in the spring than the English or Scottish farmer. Although the summer is cooler, the winter is milder, and he can generally out-winter the stores by providing a supply of hay. It is true that during the winter the cattle make little growth, in fact often go back, but at least they have been brought through the winter at comparatively little cost, and may be counted upon to go ahead on the spring and summer grass.

Within recent years, however, there has been a growing tendency towards early maturing beef. The householder of England no longer wishes to buy the big joints of former days. It is the small joint which finds the ready market. The tendency is not confined to Great Britain; it has developed to such a marked extent in the United States that the meat-packing

companies no longer purchase, if they can avoid doing so, the big three or four year old bullock. It seems probable, therefore, that the future holds little prospect for the 9-11 cwt. store bullock. What is wanted to-day and increasingly so in the future is the 8-10 cwt. prime fat bullock.

With the object of securing some data concerning the production of Baby Beef in Northern Ireland two preliminary experiments were carried out during the period October 1922 to June 1923 and a further series during 1923-4. As the results have already been published,[1] it will suffice here to indicate the main trend and results of these experiments. The 1922-3 experiments were carried out with calves sired by a pedigree Aberdeen Angus bull and out of cross bred dairy cows of the Shorthorn type. The calves were born in June 1922 and were all pail reared, receiving whole milk for the first month only. They were brought in for winter feeding on November 1st and were then divided into two lots. Lot 1 were pushed for Baby Beef and Lot 2 were reared as Stores. Each lot of calves received turnips and hay *ad lib.*, the only difference being that Lot 1, Baby Beef, received from 3 to 6 lbs. per head per day of a mixture of equal parts of bruised oats and linseed cake. The experiment was continued till June 11th, when the cattle were all approximately 1 year old. The experimental cattle were sold by public auction at Belfast, and prior to the sale were housed in special pens and demonstrated to a large body of farmers.

The results are summarised in the following table :—

	Weight in Sale Ring.			*Price realised at Auction.*		
	Cwt.	qr.	lb.	£	s.	d.
Baby Beef lot (average) ...	7	3	22	24	5	0
Store lot („) ...	4	2	14	12	10	0

The extra cost of feeding the Baby Beef cattle amounted to £4, 14*s.* per head, leaving a profit in favour of the Baby Beef cattle of £8, 1*s.* per head.

The experiment gave rise to considerable comment, most of it of a very critical nature. Three main criticisms were made by the farming community.

(1) The animals were half-bred Aberdeen Angus cattle. The cross is not a common one in the North of Ireland, and therefore the results were not generally applicable.

(2) The selection of the calves into lots was made by the experimenters and there was always the possibility that they were biased.

(3) The best farmers gave their store cattle a little bruised oats, whereas the experimental store cattle received turnips and hay only.

With the object of meeting these criticisms and of maintaining and, if possible, increasing the interest which had been aroused, a

[1] "Report on Baby Beef Experiments," Technical Bulletin No. 1. Copies may be obtained free of charge on application to the Secretary, Ministry of Agriculture, Northern Ireland, Wellington Place, Belfast.

fresh series of experiments was started. It was arranged that one of the next series of experiments should be carried out with Shorthorn calves all sired by the same pedigree premium Dairy Shorthorn bull and out of ordinary cross bred dairy cows. The milking record of the bull's dam was 14,226 lbs. of milk in 45 weeks and the average yield of the cross bred dairy cows was 724 gallons, half of the dams being heifers. The calves were all pail reared and received whole milk for one month only.

Before the calves were divided into lots they were ear-marked by means of numbered metal tags, and the calves from each experimental centre were taken up by motor lorry to Belfast, publicly exhibited in the Auction Market and divided into lots before an interested crowd of spectators by Mr. J. Laurie, the Belfast Manager of the British Argentine Meat Company, and Mr. W. R. Morrow, the President of the Ulster Farmers' Union.

In each experiment the cattle were divided into three lots and were treated as follows :—

Lot 1. Baby Beef—treated as previously indicated.
Lot 2. Stores receiving 1 lb of bruised oats per head per day.
Lot 3. Stores—turnips and hay only.

The experiment commenced on October 16th and finished on May 26th, when the calves were 13½ months old. The cattle were taken from the experimental centres and exhibited at the Ministry of Agriculture's Educational Exhibit at the Royal Ulster Agricultural Society's Show at Belfast and subsequently sold by public auction in Belfast.

The results completely confirmed those obtained in the previous year. The Baby Beef calves sired by the pedigree Dairy Shorthorn bull realised £23, 10*s* per head, and left a profit after deducting the extra cost of feeding of £5, 8*s*. 2*d*. per head more than the Store cattle.

The conclusions from the 1923-24 experiments may be summarised as follows :—

1. No difficulty was experienced in pushing calves sired by a pedigree premium Dairy Shorthorn bull for Baby Beef At 13 months old average weights of 7 cwts. were obtained, while another lot at 16 months old had an average weight of 9 cwts

2. The feeding of 1 lb. of bruised oats per head to store cattle did not result in an increased price sufficient to pay for the oats consumed.

It was clear that the last series of experiments had satisfied the shrewd North of Ireland farmer, and several of them expressed their willingness to test for themselves the possibilities of Baby Beef production. Many of them had taken notes of the rations given on the display cards over the pens in which the cattle were housed at the Royal Ulster Show, and were quite confident that they could repeat the results.

The extent to which the two years' experimental and demonstration work had been effective was shown in the following June. The two principal firms of Livestock Auctioneers in Belfast

advertised that they would hold a special sale of Baby Beef cattle and offered prizes for the two following classes :—

Class 1. Aberdeen Angus crosses.

Class 2. Calves sired by a Shorthorn bull.

A large number of entries were received for each of the sales, and the results of one of those sales for which complete returns are available are given in the following table. With the object of showing the "weights" which found most favour with the butchers the results have been grouped and arranged as follows: cattle weighing between 5-6 cwts. live weight; 6-7 cwts.; 7-8 cwts.; 8-9 cwts. and 9-10 cwts. The age of the animals varied from 12 to 18 months. There were only one or two isolated cases of animals of 18 months. No hard teeth animals were shown.

Group.	No. of Animals.	Average weight of group.	Average price of group.	Lowest price in group.	Highest price in group.	Average price per cwt. live-weight.
Cwts		Cwts. qrs lbs	£ s. d	£ s d	£ s d	s. d.
5 to 6	4	5 2 20	15 8 0	15 0 0	16 0 0	54 6
6 ,, 7	18	6 1 19	17 14 4	15 0 0	23 10 0	55 4½
7 ,, 8	24	7 1 19	24 3 7	19 5 0	29 15 0	64 10½
8 ,, 9	9	8 1 7	26 12 9	25 0 0	30 0 0	64 1
9 ,, 10	3	9 1 23	29 13 4	29 0 0	30 10 0	62 8
Total No. of Animals .	58					

The 58 animals were the property of 21 farmers, an average of less than three each. One farmer sent forward nine animals and another seven. Eleven of the animals were purchased by a Stranraer butcher for shipment to Scotland, five for shipment to Southport and six for shipment to Manchester.

It would appear from the results set out in the above table that the butchers preferred the animals weighing from 7 to 9 cwts., and it is probable that the ideal weight is 8 cwt, a weight which can easily be obtained at 15 months. It is further apparent that not all the farmers were successful in their efforts, and it may be helpful to examine the causes which make for success or failure.

In addition to the experiments which were under the direct control of the writer and his colleagues, demonstration experiments were conducted by each of the County Agricultural Instructors. These demonstrations were exceedingly useful, as they served to point out the difficulties which were likely to be encountered if the work was taken up rapidly by the general farming community. In the few cases where farmers were not successful in turning out prime beef at 12 to 16 months, failure was due to one or more of the following causes :—

1. Unsuitability of the bull.
2. Improper feeding.
3. A late start.

Although in the experimental work successful results have been obtained with calves out of ordinary cross-bred cows sired by an Aberdeen Angus bull and from calves out of similar cross-bred cows sired by a pedigree Dairy Shorthorn bull, it would be a grave mistake to minimise the importance of the bull. To use a bull, however good, of a slow-maturing breed such as the Galloway would be a mistake. In the case of the Shorthorn it may not, and probably does not, matter a great deal whether he is a beef Shorthorn or a Dairy Shorthorn, provided he is an animal of substance, quality and constitution and is of good type. The rapid development of the work is therefore in no small degree dependent upon the rapid improvement in the quality of the bulls throughout Northern Ireland. In this connection the live stock improvement schemes have been of immense assistance, and the new Live Stock Breeding Act already gives promise of still greater assistance. There are already a large number of premium bulls throughout the North of Ireland, and the production of Baby Beef from their calves affords a most valuable demonstration to the farming community of the importance of the bull and the economic advantages to be gained by steadily improving the standard. Two years have elapsed since the Live Stock Breeding Act came into operation. No farmer can use a bull which has not been inspected and licensed. A gradual stiffening of the standard is already manifest in a distinctly better type of bull, and Northern Ireland is already within measurable distance of the time when a very large proportion of the bulls in use will be suitable sires for Baby Beef calves.

In a few cases lack of success has been due to a too gradual increase of the cake and meal ration. When the calves are brought indoors in October at 6 to 8 months old they should be receiving within a fortnight 3 lbs. of cake and meal, and they should reach their maximum of 6, 7 or 8 lbs, depending upon the age, at least six or eight weeks before the marketing date. If the calves are not pushed with sufficient rapidity at the start of the indoor feeding period they will begin to grow rapidly. Too rapid growth increases the difficulties of fattening and results in half finished stores instead of prime Baby Beef.

It must never be forgotten that the Baby Beef animal must be considered and treated as a producer all the time. Anything in the nature of a store period is fatal to good results. February and March calves when put out to grass should go on to good pasture. They should be brought in not later than the first week in October and steadily pushed till they are ready for the butcher in May and June. The following rations have given excellent results in Northern Ireland : Roots and hay *ad lib* and 3 to 7 lbs. per head of either of the following mixtures :—

(1)		(2)	
Bruised Oats Linseed Cake	equal parts by weight.	Bruised Oats Palm Kernel Meal Linseed Cake	equal parts by weight.

The initiation of Baby Beef work in Northern Ireland is not so easy as in other parts of the United Kingdom. At least 70 per

cent. of the holdings are under 20 acres. The farmers have not the capital possessed by the farmers in England and Scotland, and cakes and meals are on the average £1 per ton dearer than they are in England and Scotland. That so many of the small farmers have taken up the work seriously is a tribute to their courage and energy.

It may be asked what are the advantages to the North of Ireland farmer of Baby Beef production compared with Store rearing or the production of 2 to 3½ year old stall fed beef? The advantages may be summarised as follows:—

1. It is a more economical method of feeding. A given weight of feeding stuffs will produce a greater increase in weight fed to a young growing animal than to a full-grown one. In the latter case a greater proportion of the food is used up in maintenance.
2. The capital invested is turned over once every 12 to 16 months instead of every 2 to 3½ years as in the case of full-grown stores or fat bullocks.
3. It provides a profitable alternative to store cattle raising if and when the Canadian competition becomes too keen.
4. It is the most profitable method of marketing cattle not required for breeding.

It would be unfair to conclude this article without paying a tribute to the help which the principal firms of live stock auctioneers have given and the enthusiasm which they have thrown into the work. The future development is largely in their hands. That they realise this is evident by the preparations they have made and are making for special shows and sales of Baby Beef animals, and the propaganda circulars they are distributing amongst their customers.

THE WOOL INDUSTRY IN SCOTLAND.

II.—THE WOOLS OF SCOTLAND AND WOOL MANUFACTURES.

Professor A. F. Barker, M.Sc.,
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Scotland possesses three wools peculiarly its own, viz., the Blackface, the Cheviot and the Border Leicester wools. These are of world-wide notoriety, and are produced in considerable bulk not only in Scotland but also elsewhere. Shetland wool is perhaps even more characteristic in its properties than any of the three mentioned, but is only produced in small quantities. Then, just as England has bred many of her sheep from Scottish stock, so has Scotland bred a considerable number of flocks from English stock, particularly from Southdown, Suffolk and Dorset Horn. Quite recently Merino sheep (Peruvian) and the noted New Zealand breed—the Corriedale—have been introduced into Scotland, but it remains to be seen whether either or both of these breeds can

withstand the climatic conditions. It is known that previous introductions of Merino blood have speedily disappeared, at least as pure breds, but there is just the possibility that the hardy Peruvian Merino—bred 10 to 12,000 feet up the Andes—may survive.

It is our desire to demonstrate the manufacturing uses and qualities of all these wools, but before attempting this it will be necessary to study broadly the evolution of the coat of the sheep, as from this study most important deductions as to manufacturing possibilities may be made.

Evolution of the Coat of the Sheep.—In fig. 1 an illuminative representation of the Vicuna is given. This shews an interesting feature—the breast-plate of hair. Now it is probable that the progenitor of the Vicuna carried the hair or outer coat all over, in addition to the under coat of fine fibre measuring about $\frac{1}{1000}$ in. in diameter. But the high altitudes of the Andes, say 14,000 feet up, seem to have eliminated the outer or hair coat—save for the breast-plate—the little creature apparently being better protected from the cold by the dense coat of fine fibre.

This broadly is also the history of the coat of the sheep. If we examine one of the undeveloped breeds—that of Kenya, for example—we note that it consists of thick outer-coat fibres or hairs, and fine under coat fibres or wool. If micro measurements are made of these fibres and a "frequency curve" drawn, then the marked variation in diameters comes markedly into evidence (see fig. 2).

The question may now be asked: What is the essential difference between Hair and Wool? And this question is not easily answered. Broadly it may be said that the fibre we speak of as

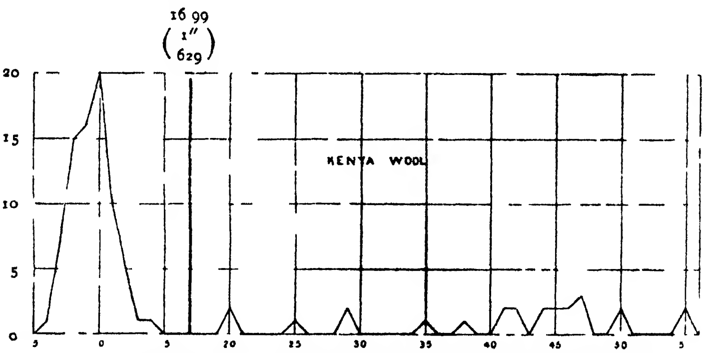


FIG. 2.—Illustrating Under and Outer Coat Fibres by Diameters

hair has a continuous medulla or central channel, while wool has no such central channel. But this definition is not wholly satisfying, we find many fibres with an "interrupted medulla" which under our definition are neither hair nor wool, and we find many fibres with the medulla which at least, from the manufacturing point of view, must be regarded as wool. Probably the suggestion made by Professor Cossar Ewart is the most illuminating, viz. that hair is a developed wool fibre, the order of evolution being wool, nondescript fibre and hair. It should be noted,

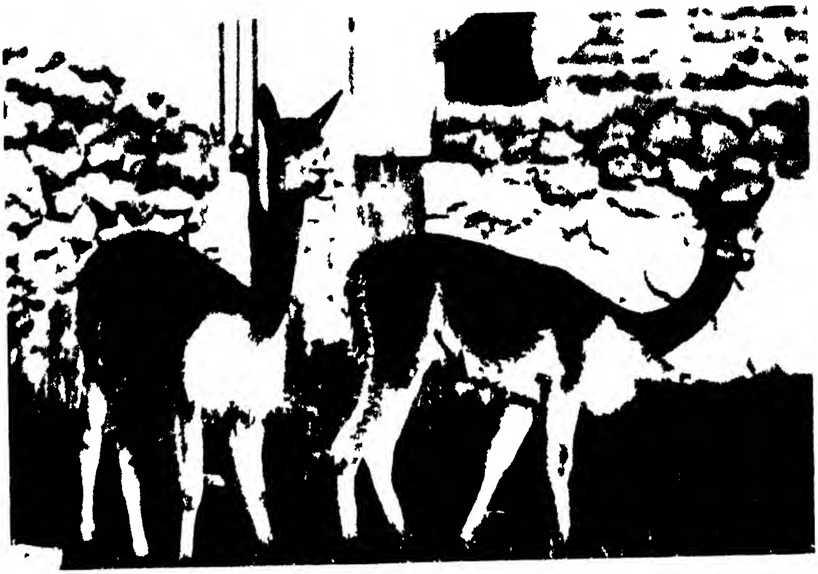
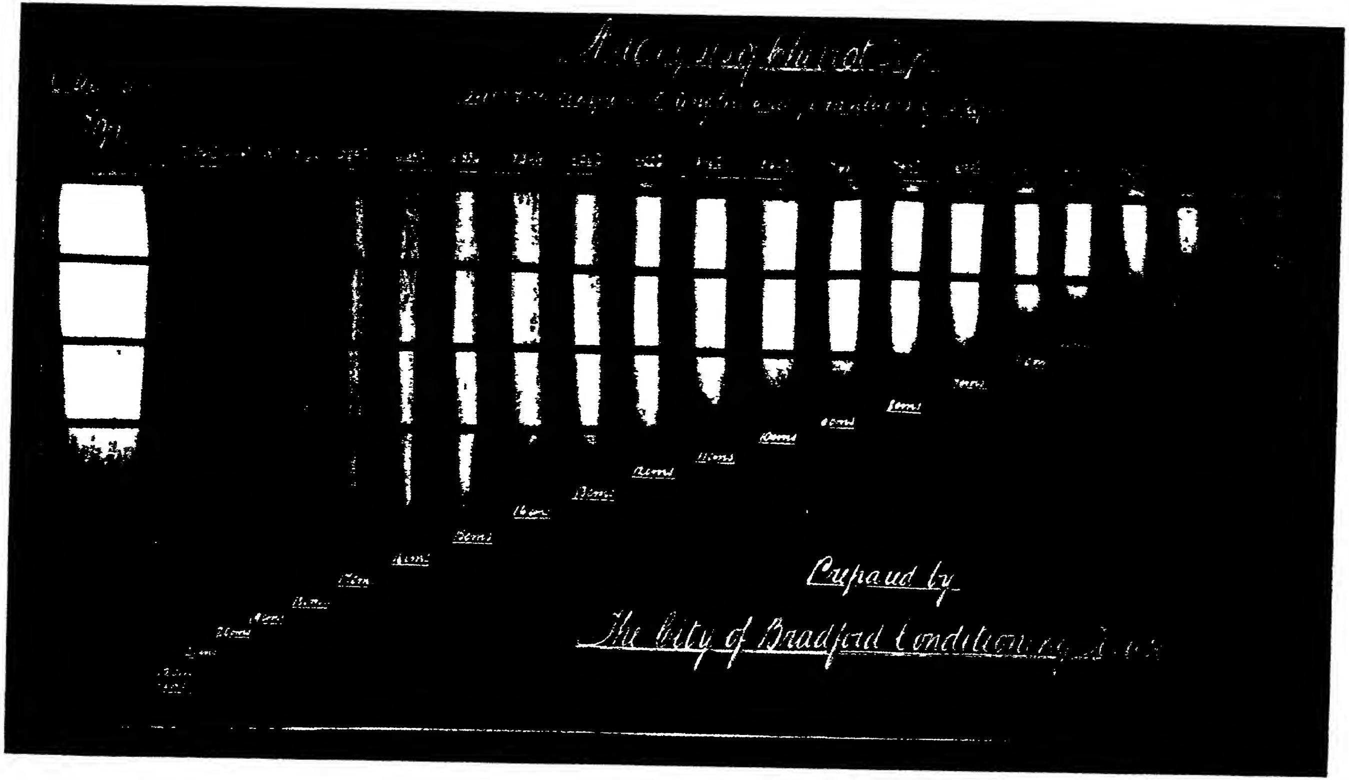


FIG. 1. VICUNA. Showing fine under coat and breast plate of hair


Prepared by
The City of Bradford Conditioning House

however, that while wool fibres grade perfectly up to the medullated fibre defined here as hair, there appears to be an absolute jump from this hair to the often short stiff hair found as the outer coat of the wild sheep.

Perhaps the best example among modern breeds of the sheep with the double coat of hair and wool, coming under our definition, is the Herdwick—a small mountain sheep bred only on the Cumberland fells. The outer hair coat of this sheep is certainly one of the strongest grown, while underneath is a coat of fine wool of beautiful quality. Iceland fleeces shew the same double qualities, the under fibre being in this case much the more valuable.

"Under-coat only" sheep can at once be thought of. The Soay or wild sheep of the Shetlands, the Southdown and the Merino at once suggest themselves to us as typical examples. But into which class must we place the long lustrous Wensleydale wool?

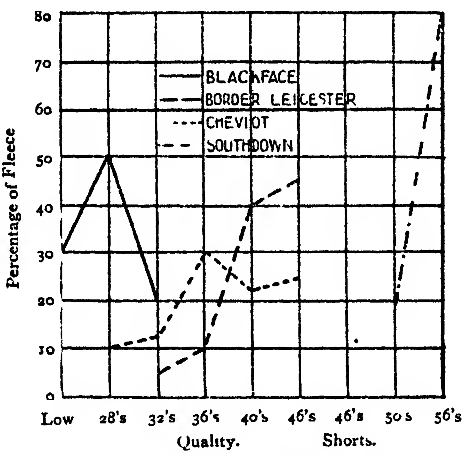


FIG. 3.—Percentage Qualities.

It must certainly go into the "wool" class; but it is so like the hair of the Angora goat (Mohair) that the whole question of the difference between hair and wool is again brought up and the suggestion given that any final decision on this matter is not yet possible. The Merino, however, is the best example of a sheep carrying the under coat only—although interesting to relate, the Merino lamb is ofter born with the outer coat of hair, which rapidly falls off. With these fundamental particulars in mind the several important wools of Scotland may now usefully come under review.

Qualities of Scottish Wools.—Before considering each of the important wools referred to in detail, some broad particulars may be usefully considered here. In fig. 3 the quality[1] ranges of fleeces of these wools is given from which the remarkable difference between Blackface and Cheviot or Border Leicester will be noted.

[1] For definition of "quality" see *Journal of the Royal Agricultural Society of England*, article on "British Wools" (reprint obtainable), 1925, pp. 32 to 77.

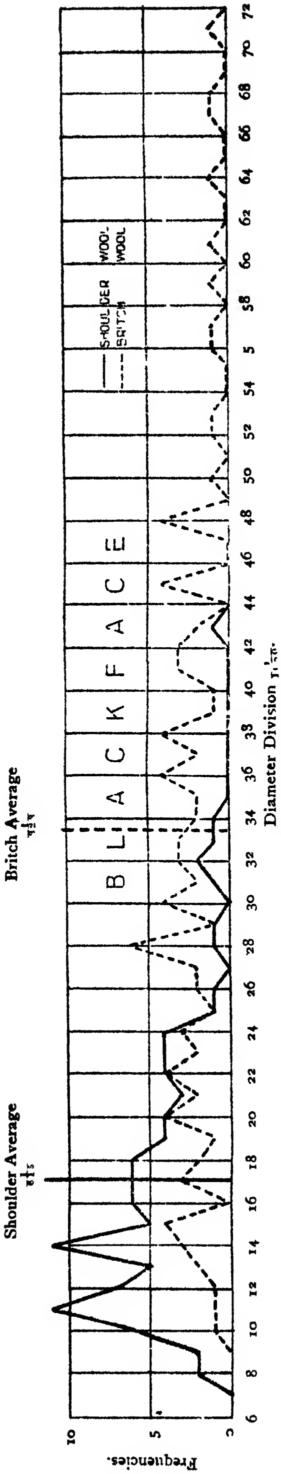


FIG. 4.—Shoulder and Britch Frequency Curves.

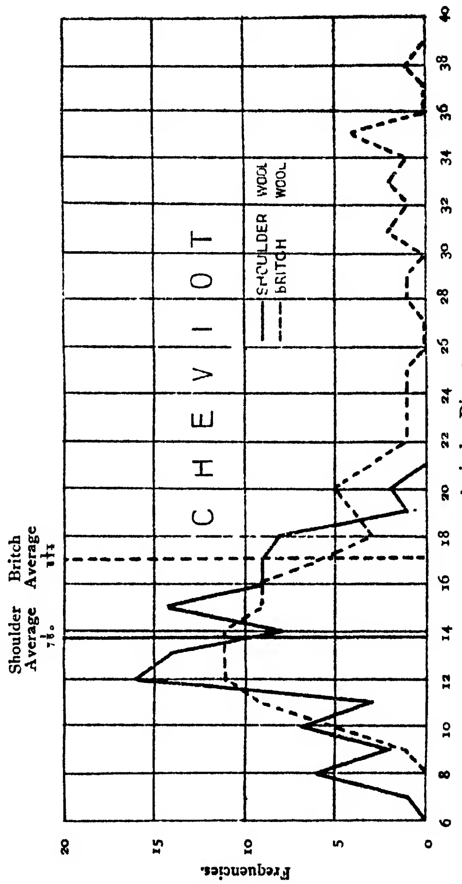


FIG. 4A.—Shoulder and Britch Frequency Curves.

Again in fig. 4 "frequency curves" for "shoulder" and "britch" wool of each breed is given, from which it will be gathered that not only does each breed shew a marked difference, but also that fleeces of the same breed shew a marked difference, the shoulder wool usually being on the average much finer than the hind-quarters wool and much more uniform. Now just as fineness is an important matter from the manufacturing point of view, so also is length. The fibres from a square-stapled Merino wool vary very little in length, but the fibres from a pointed-stapled Blackfaced wool vary very much in length. Passing the wool through these processes preparatory to spinning results in further breakage of fibre in both cases, so that the lengths of fibres in the ultimate thread vary very considerably, and as the strength of the resultant thread and fabric depends upon the fibre length being conserved so far as ever possible, a method of length-analysis has been devised which is illustrated for Cheviot wool in fig. 5. These analyses may further be graphed[1] as shewn in fig. 6, from which

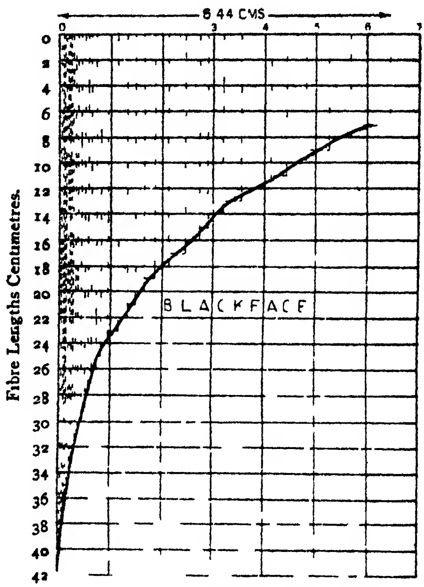


FIG. 6 —Top Analysis of Blackface.

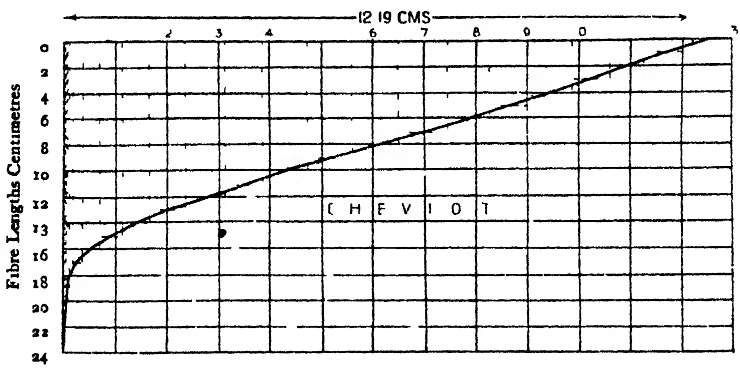


FIG 6A —Top Analysis of Cheviot.

graphs the spinner and manufacturer may make deductions respecting the resultant yarn and fabrics.

Before comparing the finished fabrics from these respective wools it will be useful carefully to consider the spinning and manufacturing qualities of each, noting the special properties which are the factors in deciding the particular uses to which each shall be put.

[1] See *Journal of Textile Science*, Aug. 1925, "British Pedigree Sheep Breeds."

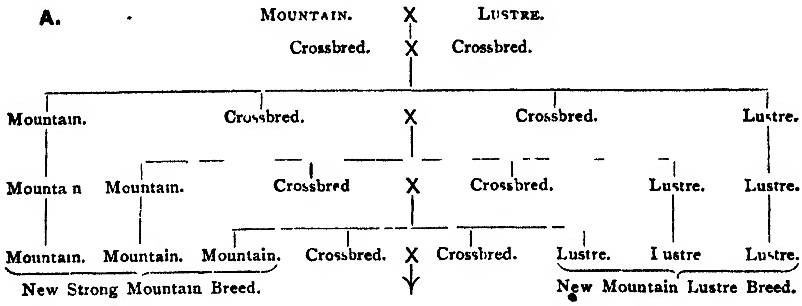
Blackface Wools.—These wools have claimed particular consideration of late,[1] as they shew interesting gradations from hair to wool. If these wools are combed, the long fibres, termed "top," are found to be remarkably strong, while the short fibres, termed "noil," are found to be fine and soft. Thus this wool may be used just as it comes off the sheep's back—hair and wool fibres mixed together; or it may be combed, and the strong "top" fibre used for one purpose, and the short fine fibres for another purpose. An examination of all the "strong" wools used in the carpet trade has revealed the fact that just as the "guts" of the Blackface sheep are the strongest known, so is this wool the strongest grown, even the East Indian and South European wools being by no means so strong as the Blackface wool.

Apparently there is a great demand for carpets in the United States, with the result that while nearly all wools the world over have markedly deteriorated in value, carpet wools have well maintained their post-war advance, being three to four times the price prevailing some 20 years ago.

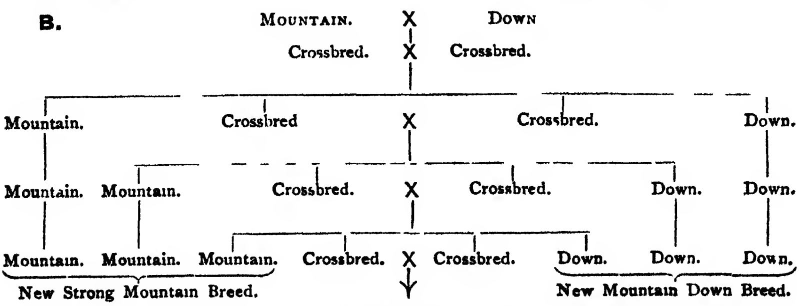
But these wools also make splendid rough tweeds for men's and women's wear, and when the rage for fine soft textures passes, these wools should be much more valuable as rough tweed wools rather than as carpet wools. It is very questionable if to-day our tweed manufacturers are really utilising these wools to the greatest advantage.

In view of the fact that it is quite easy to select Blackface flocks towards the "strong" or the "fine" side, it is suggested that breeders should definitely take their flocks one way or the other, as illustrated in the following graphs.

A.



B.



Note.—The two new types of Strong Mountain Breed might then be crossed and their progeny selected towards the strong wool.

[1] See *Journal of the Textile Institute*, XIII. (1922), pp. 40-45 and pp. 148-156.

Cheviot Wools.—These wools possess the crispness of the Down wools, the waviness of the Merino and the length of the shorter Lustre wools. They are used for the wonderful Scotch tweeds known the world over. The yarns and fabrics made from these wools are much finer than those made from Blackfaced wools, and as this wool is also much freer from "black fibre" and "kemp," tweeds of a much superior character in both texture and colour result. These wools are nearly all spun upon the woollen principle, the peculiar quality of the fibre shewing up best in the woollen cloth.

Border-Leicester Wools.—English breeders tend to regard this breed of sheep as the result of a cross between the Dishley Leicester and the Cheviot, but Scottish breeders hold that this is the true Leicester—truer than the breed at present located in Yorkshire, Lincolnshire and Leicestershire. These wools, while as fine or finer than the Cheviot wools, are more lustrous and silky. They are also slightly finer than the English Leicester wools.

In the Colonies this sheep is largely used for crossing upon the Merino, and is one of the British breeds upon which the Corriedale flocks are built up. It does not give such a weight of wool as the Lincoln breed, but upon the whole its carcase is better—hence its popularity.

This sheep crossed upon the Cheviot gives a most useful wool, termed "North," much prized by Yorkshire manufacturers.

Other Breeds.—Special mention should be made of the Shetland wool—wool which for special purposes is worth about 5*s*. per lb., but only about 5*d*. per lb. for purposes to which it is not adapted. Hence the necessity for special sales for this clip. Of late years the yield per sheep of the Shetland breed has been markedly increased through the introduction by Professor Cossar Ewart of the Shetland-Siberian Cross—the cross giving a fleece two to three times the weight of the pure bred Shetland with apparently as fine a fibre.

The Suffolk sheep—a typical "Down" breed with jet black face and legs—is proving a good "mutton" sheep. The wool also is excellent, but unfortunately may be contaminated with black fibre. The Southdown breed does not suffer from this defect, and the constitution is perhaps hardier; the carcase, however, is smaller.

The Duke of Richmond and Gordon is experimenting with various Downs and heavy wool crosses, while Lord Novar is carrying out some useful experiments with Dorset Horns. This latter breed of sheep is one of the most prolific, and yields the whitest and best milling and hosiery wool of all the Down breeds. This sheep and its crosses would seem to be one of the best worth experimenting with from both the mutton and wool point of view, although in Scotland it is hardly likely that two crops of lambs per year are possible as is the case in the South of England.

Blackface breeders will do well to try either the pure bred Peruvian-Merino or Blackface-Merino Crosses on their territory. The Merino wool is still worth twice as much as the Blackface wool to-day, and may ultimately be worth even three times as much. There are stud flocks of these Merinos at Reading

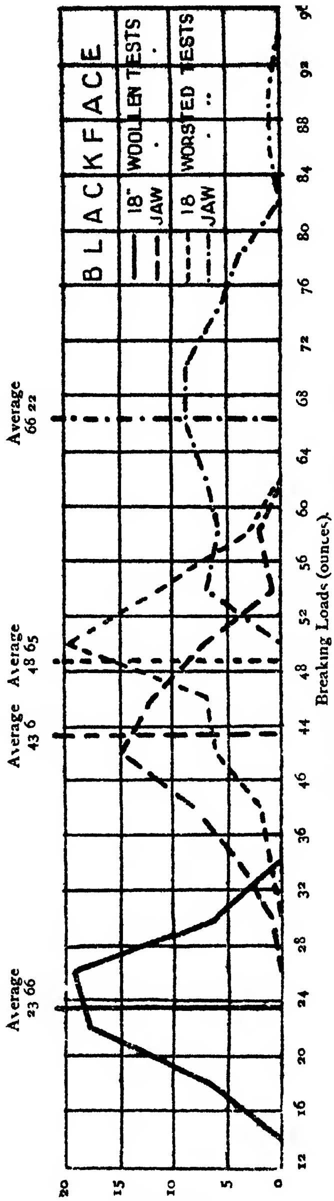


FIG 7 —Blackface Yarn Strengths (18 inches and jaw breaks)

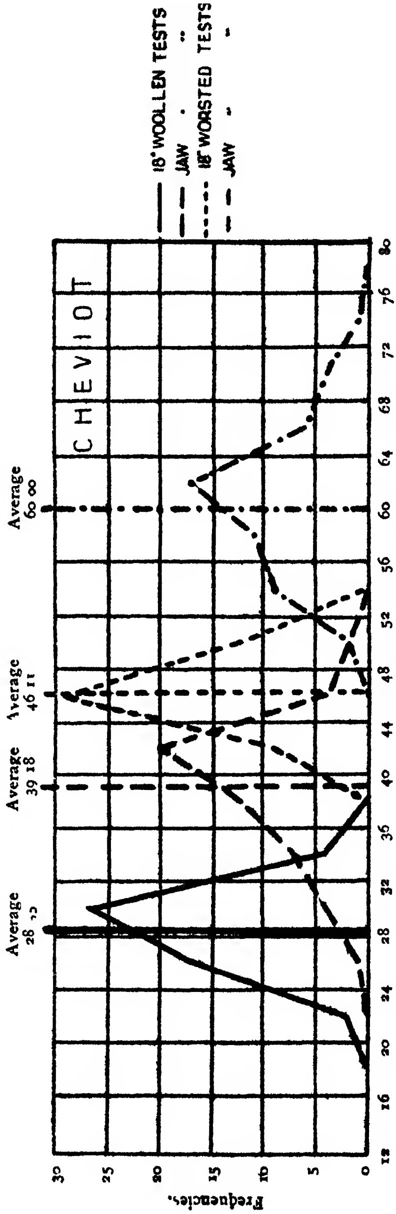


FIG. 7A.—Cheviot Yarn Strengths (18 inches and jaw breaks).

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University College and at Edinburgh University from which rams may be procured.

All these breeds and wools have come under the observation of the Animal Breeding Department of Edinburgh University, while the University of Leeds is always willing to give advice with reference to the manufacturing possibilities of wools submitted to it, and in some cases to carry out spinning and weaving investigations.

Yarns and Cloths from Scottish Wools.—In fig. 7 strength records for woollen and worsted yarns spun from Blackface and

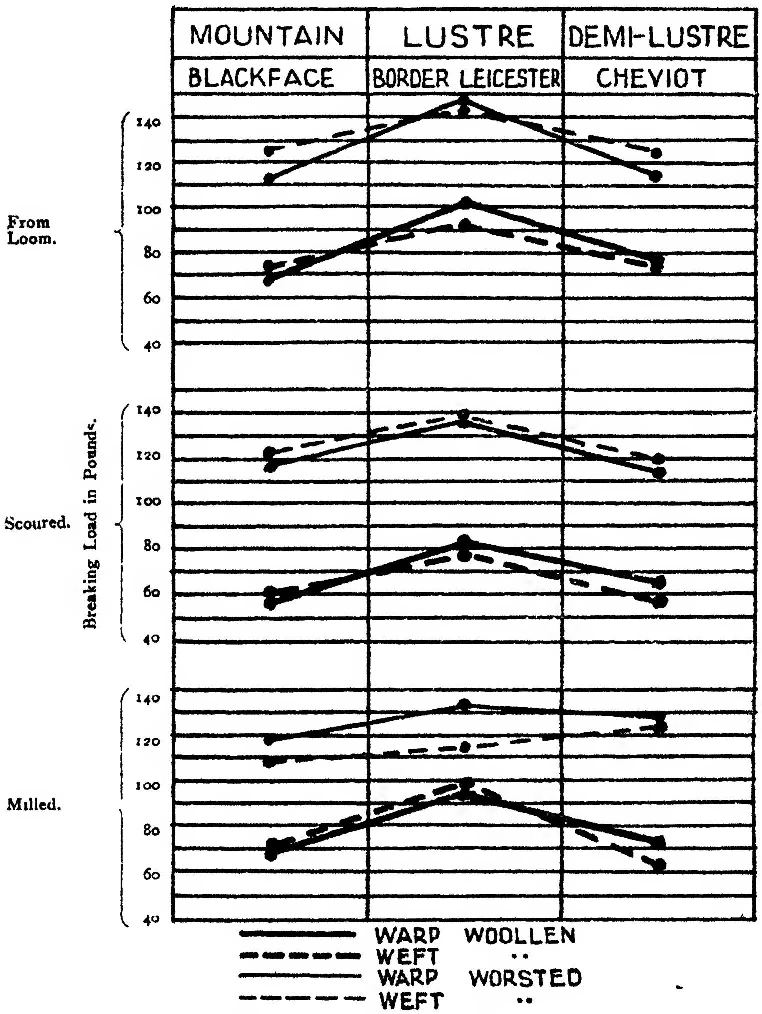

FIG. 8.—Cloth Strengths Graphs.

Cheviot wools are given. To the manufacturers these results are very useful and illuminating, shewing clearly how strength is obtained in the resultant cloth.

In fig. 8 cloth strength graphs (woollen and worsted) from Blackface, Cheviot and Border Leicester wools are given.[1] These

[1] See *Journal of Textile Science*, Aug. 1925.

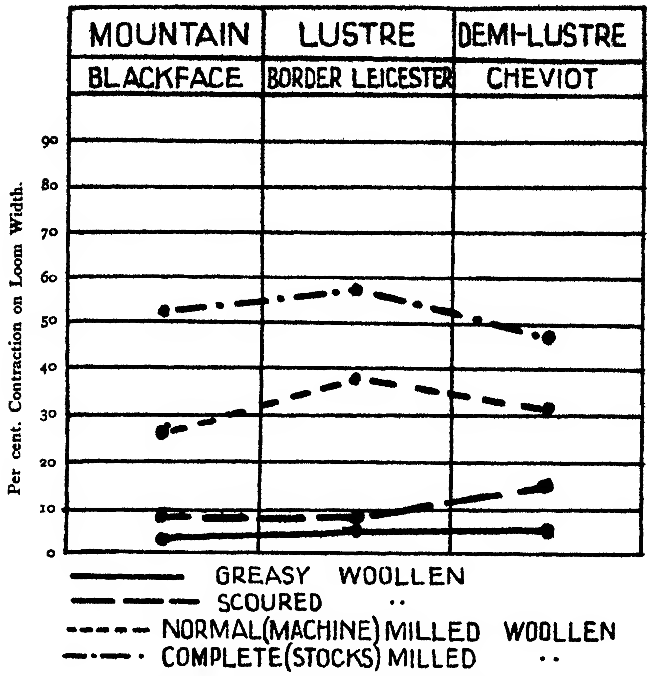

FIG. 9.—Cloth Milling Graphs, Woollen.

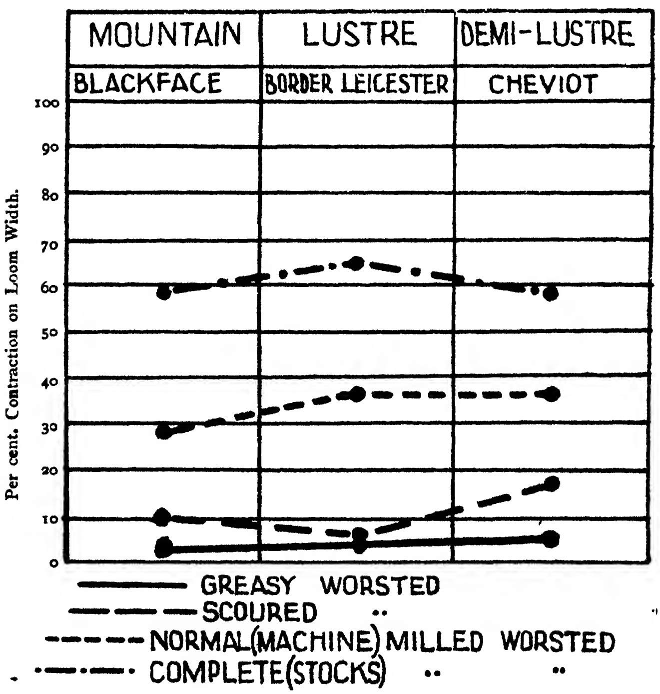

FIG. 9A.—Cloth Milling Graphs, Worsted.

results again are of first importance to manufacturers, especially if engaged upon Navy and Army contracts.

Perhaps even more interesting are the contraction or milling results illustrated in fig. 9. The difference between "contraction" following scouring and complete milling illustrates how careful one ought to be to obtain the true facts upon such matters.

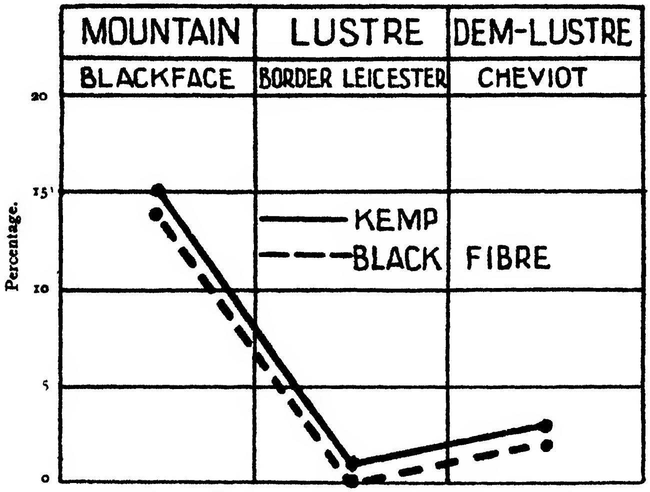

Fig. 10.—Percentage of Kemp and Black Fibre.

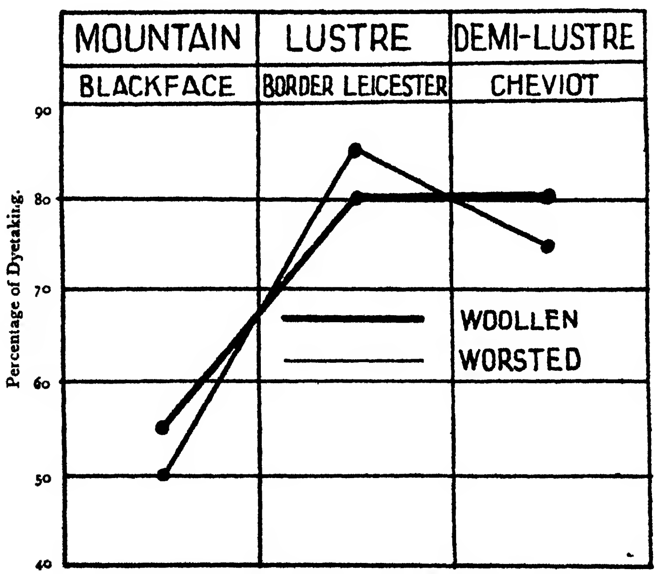

Fig. 10a.—Dyetaking Quality as a Percentage.

Of course time means money, so that for milled cloths wools which easily mill ought to be selected. That the long wools mill better than many of the shorter wools and that worsted cloths mill better than woollen cloths are really astounding results which, when known to the manufacturer, may be used to great advantage.

In fig. 10 graphic representations of "percentage of kemp,"

"percentage of black fibre" and "percentage of dye-taking" are given. Needless to say these facts also are of much importance to the manufacturer.

Methods of Marketing.—Wool in the British Isles is often marketed by private treaty, the wool stapler visiting the farmer after the shearing season and making his offer. Large quantities are sold at the great Wool Fairs—Leith for example—when the wool staplers turn up in strength. In the South of England wool is now being sold on a co-operative basis, the clips being collected and classed and sorted. There is also a movement on foot to institute one big sale for English wools right in the heart of the manufacturing district—say Bradford. This method might well be advocated for Scotland as well. At present it seems probable that the peculiar values of the wools under consideration are not fully realized, and that were the wools actually brought under the hammer where spinners and manufacturers could see them and fully appreciate their possibilities, better prices could be realized and a marked development in fabrics made from British wools be recorded.

Export of Scottish Wools.—As already noted, large quantities of Blackface wool are exported to the United States largely for carpet manufacture. Nearly all the Border Leicester clip and a considerable part of the Cheviot clip are taken by the wool-manufacturing district of Yorkshire, while still smaller quantities are suited for the hosiery industry of Leicester and district.

No exact statistics of wool exports from Scotland nor of the Scottish wool industry are yet available, but in the near future this defect in trade organization is to be rectified.

SOIL INVESTIGATIONS.

I.—SOIL INVESTIGATIONS AND THEIR BEARING ON FIELD EXPERIMENTAL WORK.

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Difficulty of Interpreting Results of Field Experiments.—Every year very large numbers of field experiments are carried out by farmers, county organisers and the central staffs of agricultural colleges. This is as it should be, for the field experiment is the final criterion by which the new discoveries and the more abstract experiments and theories are tested. The problems before the various experimenters differ a little from each other. The farmer usually carries out his experiments with a view to applying the results on the same field or the same farm, whilst the county organisers and other college workers aim at making their results applicable to wide districts. The farmer's problem is the simpler, but even in his case the results obtained are often unsatisfactory, and do not appear to be applicable to other parts of his own farm.

The difficulty of interpreting and applying results from college experiments is still greater on account of the wider areas to which they should be applied, and there is now a very large mass of data available which is at present of little practical value.

Problem of Variable Factors.—Perhaps the main reason for this failure to interpret and apply the results of field experiments is that there are usually several variable factors involved.

If reliable and satisfactory conclusions are to be drawn, any effect obtained in experimental work should be attributable to one cause. Now if one factor is varied, two experiments are necessary—a control in which there is no change and the other in which the new factor is introduced. Two varying factors necessitate four experiments, three factors eight, four factors sixteen and five factors thirty-two experiments—allowing for only one control plot. As the experiments should be carried out at least in duplicate these numbers must be doubled—five factors therefore mean sixty-four experiments. Thus if the number of variable factors is high, the number of experiments which must be carried out to obtain reliable results becomes very great, and the field trial becomes unwieldy, for such experiments entail a great deal of labour. It is advisable, therefore, to limit as far as possible the number of varying factors. This means that results are obtained slowly, and there is a temptation, for example in manurial experiments, to try too many things at one time. Even if successful results are obtained, a great part of the value is lost because the reasons are not understood, and equally good results might possibly have been obtained at less cost in another way.

The variable factors might be divided into two groups :—

1. Those which are varied intentionally, such as seed, manure and time of sowing.
2. Factors not directly under control, such as soil and climate.

For the reasons given above, it is well to keep the number of intentionally varied factors as low as possible.

The factors of the second group—climate and soil—present greater difficulty.

Climatic differences may be due to differences in the season, and such differences are to some extent got over by accumulating results over several years. Climatic differences may also be due to differences in latitude, altitude and aspect. These things must be borne in mind in selecting areas for experiment and in interpreting results—especially in deciding over what areas the results may be expected to apply. The importance of taking climatic differences and variations into account, and collecting exact data on the subject, has been recognised in the establishment by the Board of Agriculture of meteorological stations at the various experiment centres.

Then there are soil differences, and it is essential to limit the variable factors in soils as far as possible. In a manuring experiment or variety trial the effects due to soil differences may be greater than those due to the different manures or varieties being

tested. It is convenient to consider soil properties as being of two kinds :—

(*a*) More or less permanent.
(*b*) Fluctuating.

Permanent Properties—Soil Profiles and Types.—Permanent soil properties might be described as those properties which characterise the soil type. That distinct soil types possessing very different and distinctive properties exist is beyond dispute, but there has been much difference of opinion in the past as to what constituted soil types and how they were to be mapped. Had these types been easy to recognise and separate they would have been differentiated, described and mapped long ago. It is now fairly generally agreed, however, that the type of soil depends not only on the kind of rock from which it is derived, but on other agencies such as climate, situation, drainage, plant life, and on the time during which these agencies have been at work—that is on the age of the soil. These differences in, for instance, parent material, agency of formation, situation and age, manifest themselves in differences in the colour, texture, general appearance and thickness of the surface soil and of the various layers of which the soil is built up. The study of these different layers has been neglected in the past, but is now beginning to receive the attention it deserves. The rock, boulder clay, sand or other substance forming the parent material becomes gradually altered. Oxidations and reductions take place; some material is dissolved out and may disappear in the drainage water or it may be redeposited elsewhere in the soil; and where there is, or has been, a covering of vegetation on the surface, this influences the colour and texture not only of the surface soil, but of the material beneath the surface.

The result is that most soils are built up of layers of material which differ from each other more or less markedly in appearance, properties and composition. The vertical section from the surface covering down to the unaltered parent material is often termed the soil profile, and the various different layers are termed horizons. For convenience in studying them, the soil horizons are usually considered in three groups :—

1. The surface layer or layers have usually had a considerable amount of material dissolved out of them and are also modified by the accumulation of organic matter. This is termed the A horizon.
2. In a great many soils there occurs some distance below the surface a layer or layers slightly heavier and more plastic than the surface layers. Some material may have been dissolved out, but there has been in these layers a re-deposition of material removed from the surface layers. This is termed the B horizon.
3. The parent material from which the upper layers have been derived and which is more or less unaltered is termed the C horizon.

It is largely by means of these horizons that soils are distinguished from one another and mapped.

A representation of a profile of one of the soil types found in East Lothian is shown below as an illustration.

Reaction.		*Description of Horizons.*
Very acid . .	A_0	Brown peaty layer.
Acid . . .	A_1	Greyish-brown organic stained layer.
Acid . . .	A_2	Greyish leached layer.
Acid . . .	A_3	Yellow and grey mottled layer of loamy texture.
Slightly acid . .	B	Compact gritty but very plastic clay. Mainly of a dark chocolate colour but with patches of grey and yellow material, and containing a considerable amount of coal particles and small fragments of sandstone.
Slightly acid . .	C_1	Practically uniform dark chocolate compact clay with slight traces of mottling.
Slightly acid . .	C_2	Uniform blue-grey drab compact gritty or gravelly clay. Relatively impervious and containing yellow, grey and reddish sandstone.
		4 feet.

The soil profile given above represents a soil which has never been cultivated. In cultivated soils, the surface layers have become mixed and are not so readily distinguishable. For instance, if the soil just described were cultivated, the layers of the A and possibly the upper portion of the B horizon would be mixed and would give a yellowish-brown loam, merging into a lighter coloured layer (with less organic matter) and then passing into horizon B.

It is possible to observe these differences in the field and to draw boundaries showing how far the various types extend. That is the aim of a soil survey. It has been found that the different types of soil distinguished and mapped in this way have definite and characteristic properties when examined in the laboratory, and that they have a very definite relation to plant growth as determined by observation and field tests. The differences on which soil types are separated must be recognisable on examining them in the field if any large area is to be mapped, and they are differences which have arisen through age-long processes and which represent more or less permanent properties.

It is not satisfactory to take the geological formations as the main basis for differentiating soils, although in many cases a change in geological formation coincides fairly closely with a soil

change. There are usually several fairly distinct types of soil on one geological formation, for the soil investigator takes account of differences in colour, texture, drainage conditions and age in the soil which the geologist frequently ignores. Again, in drift covered areas, particularly where the drift is thick, the drift and surface soil may bear very little relation to the underlying rock. The greatest danger, however, lies in attempting to correlate soils on a geological basis. Apart from the fact that differences in the rocks in the same geological formation give rise to differences in the soils, we have to reckon with the climatic factor. The Old Red Sandstone in East Lothian, for example, gives rise to a different soil from the Old Red Sandstone in certain parts of Perthshire, Fifeshire and Cromarty. There are differences in the surface colour and in the appearance of the various layers of which the soil is built up, and these visible differences are no doubt bound up with deep seated constitutional differences. The climatic differences even in a country the size of Scotland are sufficiently great to make it necessary to recognise different groups of soils. The soils in the low rainfall districts of the East and South-East differ from those of the higher rainfall districts in the West and from those of the very humid mountainous regions. These differences are quite apart from rock differences, and are due largely to weathering agencies and vegetation. The visible effects are seen in the different appearance and thickness of the layers of the soil profile from the peat or turf covering down to the parent material. Perhaps the most noteworthy difference is the greater development of leached layers in the more humid regions.

This advance in our ideas of soil types and the possibility of mapping them has been made possible through the study of soils over continents where very distinct climatic zones and striking soil differences occur. It was noted and followed up in Russia by Sibertzev and Glinka and by the Bureau of Soils in America, with the result that soil surveys are now a practical proposition, and are being pushed forward by the Americans, some of the British Dominions and several European countries.

Soil types are mapped in the field on visible differences which are the outward expression of constitutional differences. Differences in texture and organic matter indicate differences in water holding power, tillage and so forth, whilst differences in colour may be taken to indicate such things as differences in degree of oxidation and in leaching of soluble constituents.

Laboratory Examination.—These soil differences are determined in the laboratory by such methods as mechanical analyses, chemical analyses (ultimate and citric-soluble), absorptive power and various other tests, but such analyses mean little except in relation to soil types. They serve to characterise the soil type and to throw some light on its possible behaviour or on likely methods of improvement.

The practice of sending to the laboratory for examination a few ounces of surface soil taken at random, with the request that it should be analysed and the sender informed what it contains and what it lacks, is absolutely unsound. Thousands of such

analyses have been carried out in the past and have done a great deal to discredit scientific investigation. Figures which might indicate quite a satisfactory state of affairs in one type, might represent unfavourable conditions in a different type of soil At the present state of our knowledge most analyses cannot be satisfactorily interpreted except in conjunction with results of field experiments. If laboratory examination of a soil is desired, the soil should first be examined in the field to take account of its natural relationships and type, and it should then be sampled and studied in horizons. If laboratory and field data relating to that type are available for comparison, it should be possible to interpret the results obtained from such examination and to furnish useful information.

Field Trials.—The function of a soil survey is to map the soil on visible differences. To utilise the soil survey it must be followed up by laboratory work and field experiments. In carrying out field experiments, the experiment area ought to be carefully examined to ascertain whether it all belongs to one type, and when the results of the experiment are obtained, it is safe to apply these results only to that type. This assists us to eliminate the variable factors due to the permanent soil differences. Within certain limits the soils belonging to one type, under similar climatic conditions, are capable of giving similar agricultural results—the limits of variation depending on the detail with which the types are differentiated.

Fluctuating Soil Properties.—Distinct from the permanent soil properties just described, which characterise soil types, and which, as a rule, would not alter within centuries, there is a class of properties which might be termed fluctuating. The fluctuating properties represent the variation in properties of any one soil at different periods of its recent history. The soil may be in good heart, as the farmer would term it, or it may be exhausted, and this change may be brought about in a comparatively short time by such things as methods of tillage, cropping, manuring, liming and drainage, which influence physical condition and the amount of readily available plant food. The range and nature of these fluctuations will, of course, also be governed to a great extent by the nature of the more permanent type properties.

Various attempts have been made at measuring these fluctuating properties. On the physical side, the state of aggregation of the soil particles has been studied, and on the chemical side such things as the citric soluble constituents, the absorptive capacity, the humus, nitrogen, acidity and so-called lime requirements have usually been determined. These methods show differences, but the difficulty has been to obtain correlation between the analyses and agricultural results, and the difficulty in devising methods is increased by the fact that we do not know exactly what the plant is capable of extracting from the soil. A promising new line of enquiry is the determination of the exchangeable bases in the soil.

Exchangeable Bases.—Within the last few years this valuable line of attack has been opened up by the work of a Russian chemist, Gedroiz, and as the method is likely to be used a great deal, and referred to in agricultural literature, a brief description

is given below. It is really the outcome of work on the absorption of manures by soils, carried out nearly 100 years ago by two British chemists, Thomson and Way, who showed that the soil is capable of removing and retaining certain bases, such as ammonium from solutions of ammonium salts. Very briefly, the new principle that is being used is as follows :—

Soils contain such bases as calcium, magnesium, potassium, sodium, aluminium and iron. These bases are present in more than one condition and we may consider them in four groups:

1. Minerals such as orthoclase and mica — crystalline silicates and phosphates. These are soluble only to a slight extent, and we assume they become available very slowly.
2. Carbonates — these are fairly easily soluble but are absent in many soils, especially in Scotland.
3. Water soluble salts such as nitrates, chlorides and sulphates.
4. Bases present in a form in which they can be readily liberated by the introduction of another base.

It is with this fourth group we are concerned here.

By treating a soil repeatedly with a fairly concentrated solution of sodium chloride or ammonium chloride, the readily exchangeable bases—calcium, magnesium, etc.—in the soil are removed and their place taken by ammonium or sodium.

The bases present in this form seem to be loosely bound up in some sort of colloidal state. They are not readily washed out by water, but we can with some justification assume that substances so loosely held are likely to be utilised to a considerable extent by the plant. We may then picture a proportion of the substance necessary for plant life attached loosely—perhaps to the surface of soil particles, and readily detached from their position by adding solutions of salts such as are added as manures.

The assumption that these easily exchangeable bases occur on the surface of the soil particles is consistent with the fact that they are found in by far the greatest amounts in the clay fraction of the soil. Organic matter too plays a very important role in this connection, particularly the partly decomposed organic matter which is in a colloidal condition.

Let us now consider briefly in what amounts and proportions these easily exchangeable bases are found in soils. The amount varies a great deal in different soils, and although the approximate total capacity for these bases is probably a fairly permanent property for each soil type, the actual amount present at any one time in cultivated soils is almost certainly one of the fluctuating properties. They have been shown to be present in largest quantities in soils containing a large amount of clay and organic matter. Such soils may contain 1 per cent. or slightly more of exchangeable bases, whilst light sandy soils contain much less—some soils containing less than 0·1 per cent. About 0·3 per cent. to 0·4 per cent. would seem to be an average figure for the Scottish soils[1] so far examined.

[1] A. M. Smith, Edin. and E. of Scot. College of Agric., "The Exchangeable Bases in some Scottish Soils," *Journ. Agri. Sci.*, XX, 466 (1925).

It is found that calcium is usually by far the most abundant, being present, as a rule, to the extent of well over 50 per cent. of the total exchangeable bases. Magnesium comes next with 5 to 30 per cent.; sodium and potassium are present in small amounts, less than 5 per cent., and iron and aluminium are either absent in most normal soils or present in small amount.

In some soils iron and aluminium are present in considerable quantities, constituting as much as 50 per cent. of all the exchangeable bases, and in such cases the total amount of exchangeable bases is small. This does not appear to be a condition suitable for the growth of agricultural crops. It is supposed, too, that replaceable hydrogen can occupy the same position as these bases in the soil complex, and probably the main cause of acidity in the soil is the substitution of part of these bases by hydrogen.

Alkali soils, so important in certain parts of the world, are characterised by relatively large amounts of exchangeable sodium and little exchangeable calcium.

Agricultural significance of Exchangeable Bases. — What these exchangeable bases mean in practical agriculture is not yet fully known. Their study in the present sense is very recent, and it is difficult to draw definite conclusions, but the following points should be noted:—

1. It has been shown that they mean a great deal in relation to the physical condition of the soil. Soils in which calcium is replaced by sodium become puddled—the clay granules becoming broken down. This is seen in soils flooded by sea water and may explain the action of nitrate of soda on texture.

2. Their study is important in connection with the reclamation and cultivation of alkali soils which occur so extensively in some countries.

3. As already pointed out, probably the quantity of food constituents available to the plant is related to the amounts of exchangeable bases. It is, at any rate, a promising line of enquiry. The Tschernosem or Black Earth of Russia, one of the most fertile soils in the world, has a very high content of exchangeable bases, whilst pervious sandy soils occurring in districts of high rainfall and which are not, as a rule, naturally very fertile, have a low content of these bases.

4. They are bound up with the question of soil acidity.[1] Some soils which show a fairly acid reaction and which have a so-called "lime requirement" when tested by such methods as the Hutchinson and M'Lennan, nevertheless do not appear to require liming for the successful growth of most crops, whilst others which appear less acid require liming.

The explanation may be that the first, though fairly acid (that is containing a fair amount of replaceable hydrogen), contain also a good reserve of exchangeable calcium, the others, though containing less hydrogen, have but a poor reserve of calcium. If this conception is sound, it is important that the calcium in those soils which can hold but a small

[1] W. T. H. Williamson. Part II. of this article.

reserve must be kept up by regular liming, and the fact that so large a proportion of these exchangeable bases in normal healthy soils consists of calcium suggests that it is advisable to keep up the supply of lime in the soil.

It seems likely, therefore, that the study of exchangeable bases will throw light on the problems of manuring and liming. Preliminary work can be carried out on small quantities of soil in the laboratory, but for a proper study of the question the laboratory work should be tested on a larger scale in lysimeters, and it is to be hoped that lysimeter work, which to some extent combines laboratory accuracy with actual field conditions, will be carried out more extensively in the future than has been done in the past.

Manuring at present is frequently carried out on the principle of adding a little of everything in the hope of something acting. It would be much better, from the point of view of soil conditions as well as expense, if only the substances actually required were added. We should aim, therefore, at manuring on the basis of soil types, and an urgent problem before investigators is to determine the types and lay down experiments on those which are sufficiently important. Since a soil in any type may be anywhere on the scale between maximum fertility and exhaustion when an experiment is started, it would make field experiments of much greater value if they were carried out on the same plots for several years. This could be done more satisfactorily if experiment areas on the principal soil types were leased for several years or acquired by the Colleges.

Hill Pasture Experiments.—Some chemical work has been done on the soils from a series of plots on the hill area at Boghall, the experiment farm of the Edinburgh and East of Scotland College of Argriculture, where research on the improvement of hill pastures is being carried out.

The preliminary results obtained are shown in the following table:—

Plot No	Pasture.[1]	Response to Phosphatic Manuring[1]	Lime Requirement. Tons $CaCO_3$ per acre.	pH.	Exchangeable Calcium (as % CaO).
1	Good	Good.	2·8	5·9	·190
2	Rather poor.	Slow.	5·3	5·1	·074
3	Good	Good.	2·5	6·6	·419
4	Poor.	None.	6·1	5·0	·038
5	Poor.	None.	6·2	4·6	·024
6	Poor.	None.	7·4	4·7	·021
7	Good	Good.	4·1	6·0	·310

The "Lime Requirement" was carried out by the Hutchinson and M'Lennan method.

It will be observed that all the soils have an acid reaction, and plots 2, 4, 5 and 6 are particularly acid (pH 7 represents a neutral condition). Plots 1, 3 and 7 are less acid, show a lower "lime

[1] Unpublished results given with permission of Dr. W. G. Smith, Edin. and E. of Scot. College of Agriculture.

requirement" and a higher percentage of exchangeable calcium than the very acid group.

The vegetation on plots 4 and 5 is chiefly Moor Bent (*Nardus*); on plot 2 it is of a very short type, consisting largely of fine leaved Fescue and Agrostis and with scarcely a trace of clover; and on plot 6 there is a very sparse vegetation of the same type as plot 2, with whins in addition. The other plots (1, 3 and 7) have a good mixed vegetation containing broad leaved grasses and clovers.

Dressings of phosphates were applied to the plots in February 1923. Plots 3 and 7 gave a rapid response, but of the others only plot 2 showed any response, and that was in the second year and not at all marked.

The very different soil conditions in these different plots on the same hill are due to several causes. Plots 4 and 5 appear to consist of a higher proportion of acidic rocks and minerals, and were probably less rich in bases originally than the others. Plots 2 and 6 contain a good proportion of basic rocks, but the substratum is very pervious, with the result that there has been excessive leaching and most of the easily exchangeable bases have been removed. Plots 1, 3 and 7 are mainly derived from basic rocks, and are flushed or irrigated by springs which come from basic areas. Analysis of the water from the spring which flushes plot 3 showed five times as much calcium as the water from a spring above plot 4.

These results will be dealt with much more fully in a future paper.

Summary.—In conclusion it is urged that in laying down field experiments care should be taken to limit, as far as possible, the number of variables.

It would be well to concentrate at first on the most important and widespread soil types, and the experiment plots should be carefully examined to ascertain if they are reasonably uniform.

Since the results obtained on any type of soil will vary according to whether or not the plot is "in good heart" at the time of the experiment, the experiments should, if possible, be continued on the same plots for several years. This would also help to overcome the difficulty of seasonal variations. The determination of exchangeable bases shows promise of throwing some light on the state of fertility of soils. If laboratory work is to be of value, account must be taken of the soil type and of the condition under which it occurs. Samples should be taken according to horizons and full notes kept of the appearance, texture and thickness of the various layers. It is hoped that in time soil maps will be available to indicate the distribution of the types of soil. This should make it possible to predict with some degree of certainty where results may be expected to apply, and should render field experiments more useful to the agricultural adviser and the farmer.

II.—SOIL SOURNESS.

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It has long been known that many soils on which certain crops fail to grow well have an acid reaction. These are generally called

"sour" soils. The terms "soil sourness" and "soil acidity" are often used as though they meant the same thing, but it should be clearly understood that a soil is not necessarily sour or infertile although it may have an acid reaction. Many types of fertile soils are naturally acid. In fact the majority of the fertile soils sampled in the East of Scotland have been found to be slightly acid, and similar results have been reported from the examination of a large number of soils elsewhere.

Some plants cannot tolerate more than a certain degree of acidity, but there is a great deal of variation in the resistance of plants to acid conditions. In many cases an alkaline reaction has a much more injurious effect than a correspondingly acid one. Indeed, there is distinct evidence that many crops grow best in slightly acid soils. Oats have been shown to withstand a greater degree of acidity than wheat, and wheat than barley. The latter crop will often fail completely on a soil which produces good crops of oats. Potatoes and turnips will grow well in acid soils, whereas beets will not. In the case of turnips, however, an acid reaction is favourable to the spread of the organism causing "finger-and-toe" disease, and where that is prevalent the turnip crop will be very much reduced. Some of the clovers can flourish under acid conditions, while others do not grow well unless the soil is almost neutral or alkaline. The reaction of the soil—that is, whether it is acid or alkaline—is also of importance from the point of view of processes like nitrification and nitrogen-fixation which take place under the agency of certain bacteria. Such organisms also show variation in their sensitiveness to acidity and alkalinity. The nitrifying bacteria are not so sensitive to small amounts of acid as are those responsible for the fixation of nitrogen, and nitrification apparently occurs in soils which are quite acid.

When all these considerations are taken into account, it seems evident that the acidity associated with sour soils is not of itself sufficient to account for the failure of crops on such soils. Indeed, soils showing the same degree of acidity may exhibit very different results as regards plant growth, the same crop succeeding on some and failing on others. In the latter case, the acidity, while possibly an indication of conditions unfavourable to plant growth, is not necessarily the cause of the failure.

Many investigations have been and are being at present carried out in this country and elsewhere with a view to discovering the causes of crop failure on sour soils and the most suitable remedial measures to adopt in such cases. It is known that sourness can generally be overcome by liming and in some cases by proper drainage, but it is essential to discover the real causes of crop failure before remedial measures can be put on a proper scientific and economic basis. Until extensive field experiments on different types of soils have shown the proper quantities of lime to produce the desired results, much money may be wasted in haphazard applications of either too much or too little.

In the field the following circumstances are indications of sourness:—

1. Failure of the barley crop.

2. Clover not coming away well, failing to stand the winter or looking bad in the spring.

3. Finger-and-toe disease in turnips, swedes or cabbage.

4. Prevalence of such weeds as spurry or yarr, sheep's sorrel or sourocks, and mayweed or horse-gowan. (It must be remembered, however, that certain of these weeds can grow well in the absence of sourness, and it is the want of competition and their ability to tolerate a greater degree of sourness rather than their preference for it that causes them to flourish in sour soils.)

5. The disappearance of clover from pastures and the development of a thick mat of undecayed plant residues.

In the laboratory a sour soil gives, as has been already stated, an acid reaction, and, where estimations have been made of the exchangeable bases, such soils have been shown to possess less than the average content. In these cases it has also been found that the amount of exchangeable calcium or lime is low, and that certain substances like aluminium and iron appear in considerable proportions among the exchangeable bases. The aluminium and iron together with replaceable hydrogen are probably taking the place of some of the calcium and other common bases in the soil complex. The presence of replaceable hydrogen would account for the acid reaction, while, owing partly to this and partly to the low amount of exchangeable calcium, such a soil would be expected to absorb lime readily, and it is on this ability to absorb lime that the various methods of determining the so-called "lime-requirements" of soils are based.

Among all the properties exhibited by sour soils it is difficult to designate any single one as the factor responsible for crop failure, and indeed it may not be one single factor, but a combination of factors, which accounts for the infertility in such soils. There has been a tendency in recent years to attribute the failure of growth to the presence of the soluble aluminium compounds generally found in sour soils, as it is well known that aluminium compounds have a very harmful effect on most plants. A considerable amount of evidence has been obtained in support of this contention, but the problem, like all problems connected with soils, is a very complicated one, and it is doubtful if we are yet in a position to state definitely that this or that factor is the cause of crop failure on sour soils except, perhaps, in very particular cases. There is need, therefore, for a great deal more experimental work on varied soil types.

It is perhaps comforting to know that, whatever the causes of the condition known as "sourness," it can generally be ameliorated, if not cured, by the application of lime. A certain amount of calcium is essential to plant growth, but it is rarely, if ever, that the supply of this element in the soil falls below the quantity necessary for the individual requirements of the plant, so that the effects of lime upon the crop itself are chiefly secondary. Lime acts mainly upon the soil, bringing it into a condition more favourable to plant growth, and regulating the absorption or

effects of other substances as regards the plant. The chief functions of lime in the soil are as follows:—

1. It reduces acidity or entirely neutralises it.
2. It prevents substances like aluminium having a harmful effect on plant growth, either by rendering them insoluble or by giving greater vigour to the plant.
3. In some soils it causes the plant to absorb a greater amount of nutrient elements such as potassium.
4. It aids in hastening the decomposition of plant residues or other organic material.
5. In soils in which soluble phosphates would tend to combine with iron or other compounds to form very insoluble substances it prevents this happening, and helps to keep the phosphate in a form readily available to the plant.
6. It improves the physical condition of heavy soils by giving the clay a more granular structure and rendering it less impervious to water, thus causing the soil to be more easily worked.

The maintenance of the supply of calcium in a soil is, therefore, of great importance, and almost as much attention should be paid to it as to the maintenance of the nitrogen, potash and phosphate supplies. There is no doubt that since the practice of liming has fallen into abeyance and the use of artificial fertilisers has increased, many soils in this country have become a great deal more acid than they need be, and in some cases have actually become sour. Lime may be lost from a soil in several ways—a certain amount is removed annually by crops and grazing stock; a large amount disappears in the drainage water, and this loss is increased by the use of artificial fertilisers except such as contain calcium. In order to maintain the fertility of the soil these losses must be made good, and, where the wastage has remained unchecked for many years, the soil will have lost in fertility and may even exhibit signs of sourness.

Various forms of lime are available for agricultural purposes, the chief of these being:—(1) quicklime or calcium oxide, either as "lime shells" or "ground lime"; (2) slaked lime or calcium hydroxide; (3) ground limestone, carbonate of lime or calcium carbonate. The first two forms are best applied in the autumn, but the latter may be applied in the spring. As there is a great deal of variation in quality, lime should always be bought on an analysis. Eleven cwt. of quicklime are equivalent in effect to 15 cwt. of slaked lime or 1 ton of ground limestone of the same quality.

The exact amount of lime to add to a soil in order to remove sourness or to maintain fertility depends upon several factors, and, in the present state of our knowledge, is a subject upon which it is impossible to give accurate advice. Many chemical methods of determining "lime-requirements" are known, but these only estimate the amount of lime which a soil will absorb under certain prescribed laboratory conditions, and that may bear no relation whatsoever to the actual need of the soil or the plant for lime. These methods have, therefore, to be used with great caution.

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Until extensive field and lysimeter or drain-gauge experiments have been carried out on the chief soil types in this country with a view to discovering the response of these types to liming and the quantities of calcium annually removed from them under various conditions, advice on the quantity of lime to apply in any particular case can only be empirical. In the meantime a great deal can be done by applying dressings of lime to small portions of the soil showing signs of sourness in order to test whether the return obtained is worth the expense involved. The quantity required in the first instance may be large, but it will generally be found that, if the desired result is produced, very much smaller amounts, if regularly applied, will prevent the return of those conditions which necessitated the heavy dressing with its correspondingly large outlay of money.

Care must sometimes be taken with certain crops to avoid applying excess of lime. For instance, the application of too much lime may aggravate the disease known as "grey leaf" in oats, and, if the soil does not contain sufficient organic matter, may result in the potato crop becoming affected with "scab." In consequence, lime should not be applied to a soil immediately before an oat or potato crop. Probably the best time to make the application is before the root crop, and in any case for most crops it is not necessary to add enough lime to ensure a neutral or alkaline reaction. The quantity required to cure sourness may be considerably less than that necessary to neutralise the acidity of the soil. It may happen, however, that the former quantity may be large enough to make the cost of application prohibitive, especially if the lime has to be transported a long distance. In such cases it might be more feasible to draw up a system of farming including those crops which are more tolerant of sour conditions, such as oats, rye, potatoes and certain grasses. The knowledge gained from further experimental work on the sensitiveness of crops and of different varieties of the same crop to sourness would be of great practical value in devising such a scheme.

THE INFLUENCE OF ULTRA-VIOLET LIGHT ON NUTRITION.[1]

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THAT sunlight has a great influence on plant life has long been known. Strangely enough, it is only very recently that we began to realise something of the effects of sunlight upon the animal organism. If one had asked the average medical man, say ten years ago, whether sunlight had any effect upon health, he would probably have replied somewhat evasively. No doubt he would have said that sunlight was, from a psychic point of view, very

[1] This article is adapted from a paper delivered at the Scottish Agricultural Research Conference, Edinburgh, July 1925.

stimulating, and he would have pointed out that it was difficult to separate the influence of sunlight from that of those factors which generally accompanied it, viz. fresh air and change of environment.

Within the last few years, however, great advances have been made, and what was once thought to be a vague general influence is being widely used as a specific therapeutic agent. This advance has been due largely to the renewed interest in the question of rickets, to the stimulus given to research by the vitamin hypothesis, and to the somewhat tardy realisation of the importance of what, for want of a better term, has been called "mineral metabolism." It must be added that the advance was made possible only by the development of biological and chemical methods, and by the production of suitable artificial sources of ultra-violet light.

Beyond the violet end of the visible spectrum lies the invisible ultra-violet region, and it is the rays in this region which possess so many health-promoting properties. The main source of ultra-violet light is, of course, the sun. While direct sunshine is rich in ultra-violet light, so also is the sunlight reflected from a clear blue sky. Though these rays are so potent in their influence they have no great penetrating powers. Thus they are, to a large extent, held back by a smoke and dust-laden atmosphere, and while they pass easily through quartz glass, they almost completely fail to penetrate ordinary window glass.

There are several methods of producing ultra-violet light artificially, but for our present purpose we need only mention the carbon arc lamp and the mercury vapour quartz lamp. The latter has many advantages when local application of the rays is required, but the carbon arc is more convenient for general irradiation of large areas for long periods; we have used this type throughout in our experiments. Some advantage probably lies in the fact that its spectrum very closely resembles that of sunlight.

In 1919 Hauldschinsky discovered that ultra-violet light had a curative effect in rickets. To-day the treatment of rickets by this means has become an established practice. Clinically the improvement following irradiation is rapid and marked. Further, X-ray examination shows that solid bone-formation is initiated. And again, chemical examination of the blood reveals an increase in the serum calcium, in the inorganic phosphorus or in both. Clearly ultra-violet light has a profound influence on the faulty mineral metabolism of rickets, be the cause of that faulty metabolism what it may.

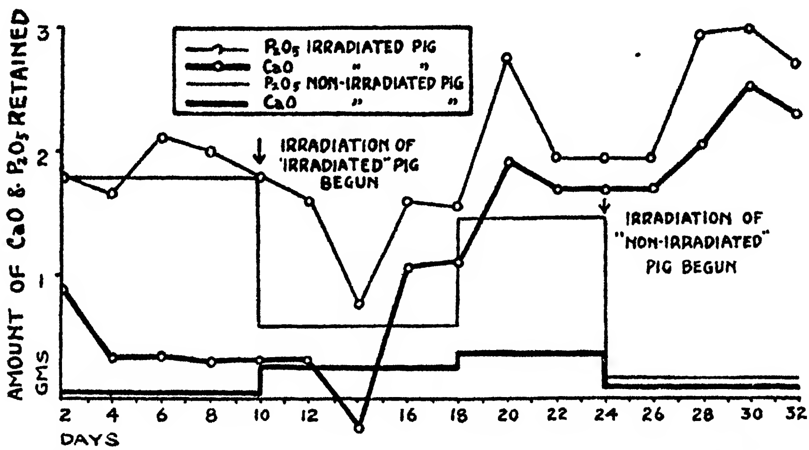
What is the influence of ultra-violet light upon the mineral metabolism of animals which are nearer the physiological normal? This is a question which we are endeavouring to answer in a series of experiments begun about eighteen months ago at the Rowett Institute (1), (2).

For our purpose pigs were selected since they possess many advantages. They are suitable animals for confinement in metabolism cages. They have no thick coat to interfere with irradiation of the skin. They have a very active calcium and phosphorus metabolism, the growing pig of about eight weeks retaining roughly 5 grams of calcium (CaO) and 5 grams of phosphorus (P_2O_5) per

day. Finally, and by no means least important, a good deal of data and experience had already been gathered at the Institute as a result of metabolism experiments on the pig.

In one of our experiments three pigs were kept in metabolism cages. One was in the diffuse light of the animal room, and in the case of the two others the cages were darkened. Of these two, however, one was irradiated for one hour daily at a distance of three feet from the carbon-arc lamp. All three animals were fed on the same fixed diet, which was considered to be well balanced as regards its calcium and phosphorus content. It consisted of maize meal, oatmeal, middlings, olive oil and blood meal, with the addition of 20 grs. $CaCO_3$ and a small amount of NaCl.

The total calcium intake per day was 11·94 grms. CaO and that of phosphorus 12·77 grs. P_2O_5. The ratio of CaO to P_2O_5 was therefore roughly 1 : 1. This is the ratio in sow's milk. Every 48 hours the fæces and urine were collected separately and their



Showing the increased retention of Calcium and Phosphorus in the irradiated Pig and the low retention in the control.

amounts determined. Their nitrogen, calcium and phosphorus content was estimated. Thus it was possible to follow from day to day the amounts retained. Without entering into details of the results, suffice it to say that, as far as calcium and phosphorus retention was concerned, there was, over a period of 50 days, no great difference between the "darkness" pig, the "diffuse light" pig and the "irradiated" pig. Such small difference as there was, however, was in favour of the irradiated pig.

This result is in striking contrast with that obtained in another experiment very similar in its general lines, but differing in one important point—namely, the balance of the diet. Thus, two growing hog pigs were kept in darkened metabolism cages for some 32 days. One pig was irradiated for one hour daily at three feet; the other was not. The diet consisted of maize meal, oatmeal, middlings and some added calcium carbonate. The daily P_2O_5 intake was 10·2 gms. and the CaO intake 4·11 gms. Thus the P_2O_5 to CaO ratio was about 2 : 1.

It will be seen from the graphs representing the amounts of

CaO and P_2O_5 retained by the non-irradiated pig that it remained on a very slightly positive balance. Towards the end of the experiment its condition was far from satisfactory. The irradiated pig compared very favourably with it. I wish to draw particular attention to the calcium and phosphorus balances in the latter. It will be seen that following shortly upon irradiation there is a significant fall in the amounts of CaO and P_2O_5 retained. In the case of calcium there is actually a negative balance. This is a point to which I shall revert. Thereafter, however, there is a rapid and continuous rise in retention until what is probably about a maximum is reached. The parallelism of the CaO and P_2O_5 curves is marked during the light period; it suggests that the calcium and phosphorus are being absorbed in an optimum ratio.

The great increase in the amounts of calcium and phosphorus retained is entirely due to a diminished excretion of these in the fæces. The interesting fact emerges that their excretion in the urine shows a coincident increase. The inference seems clear that the absorption of these minerals from the alimentary tract has been greatly stimulated by the ultra-violet light.

At the end of the experiment both pigs were killed. Analyses of the bones showed that while the ratio of CaO to P_2O_5 was practically the same in both, the actual percentages of these was definitely higher in the irradiated pig. It is interesting to note that these results have been recently confirmed on a practical scale by certain American workers (3).

	Irradiated Pig.		Non-irradiated Pig.	
	Tibia and Fibula	Ulna and Radius	Tibia and Fibula.	Ulna and Radius.
Wet weight of bones	140·99 g.		108·93 g.	
% Ash in dry fat-extracted bone ...	45·86	43·39	39·77	41·23
% CaO in dry fat-extracted bone ...	24·25	23·35	20·84	22·17
% P_2O_5 in dry fat extracted bone ...	20·32	18 39	18·12	17·39

The conclusion drawn is that irradiation, under certain conditions, can cause a greatly increased retention of calcium and phosphorus by the pig, and that such retention results from an increased absorption from the gut. A comparison of this and the previously described experiment shows that irradiation exerts its maximum effect when, as the result of a badly balanced diet or from other cause, the retention of minerals is low. When the retention is already good, irradiation may have little influence.

A repetition of the second experiment giving a shorter irradiation, but administering small doses of eosin, which sensitises the animal to light, in general confirmed the previous work. Other workers have since obtained similar results employing rats and goats.

That such results have a definite practical application is shown by some earlier experiments on the influence of sunlight on growth

in pigs, carried out at this Institute in 1920 (4). It was found that young pigs in dark pens put on less weight and at the end of the experiment were in a less "thrifty" condition than pigs which had been reared in pens in which the animals could obtain exposure to the direct rays of the sun. It was noted in these experiments that when the diet was deficient in mineral matter the beneficial effect of light was more striking. One seems at least warranted in deducing from all the above work that unless a diet, ideal as regards its mineral content and mineral balance, is being fed, light will have a beneficial influence on the growing animal.

If ultra-violet light has such a marked effect upon the organism during the period of growth, it is natural to suppose that it may have an influence at other periods when mineral metabolism is particularly active. Pregnancy and lactation are two such conditions. As far back as 1922, Dr. Orr had tried the effect of irradiation on the milk yield of a cow. No immediate increase in the yield was noted. In view, however, of the results obtained with pigs, we started last year a series of metabolic experiments with a lactating goat. In all, three experiments have been carried out and the fourth is still in progress. I shall confine my short account of the results to the case of calcium, since in the lactating animal this would seem to be the key mineral. Generally speaking, it has been found in metabolic experiments that an animal in full milk is on a negative calcium balance; it is drawing upon the storehouse of its own skeleton for the needs of its offspring. If this debit balance is small it may be of little importance. In the case, however, of an animal with a very heavy milk yield, the importance of continuous calcium loss may be great. Even though we may regard a continuous but small negative balance in the lactating animal as physiological, it is nevertheless possible that it entails an element of strain, just as the burden of pregnancy may aggravate pathological processes, though pregnancy itself is a physiological condition. The relation of heavy milk yield with continuous calcium loss to the incidence of disease is a subject of prime importance. Hart, Steenbock and Humphrey (5) have shown, for instance, that privation of calcium adversely affects reproduction in cows.

On the assumption that during lactation a loss of mineral matter from the body is a normal process, Orr (6) sums up the situation as follows: — "During pregnancy some regulating mechanism may stimulate the absorption and storage of minerals and after parturition an associated regulative process may bring about the mobilisation of the stored material to supply the amounts required for milk formation. If this is so, then with high milk yielders it may be impossible to prevent a negative balance during lactation, and the problem will then resolve itself into building up as large a store as possible in the pre-lactation period; and during the lactation period, giving a supply of minerals in the best possible form and combination to ensure that the loss will be at a minimum rate." The following experiments will show, I believe, that we will be materially helped towards this end, by the application of ultra-violet light.

Throughout the experiments the goat's diet, with minor altera-

tions in quantity, consisted of maize meal, oatmeal, linseed meal and hay. The collection and analyses of milk, urine and fæces was done in four-day periods. The usual method was to run a sixteen-day pre-period, a sixteen-day irradiation-period and a sixteen-day post-period. In the three completed experiments the effect of the light treatment has been slightly but definitely to raise the amount of calcium retained. As will be seen from the Table, in one case a small negative balance was actually converted to a small positive one.

Daily Averages in Grams Ca.	Experiment I.				Experiment II				Experiment III.			
	Pre-period.		Irradiation-period.		Pre-period.		Irradiation-period.		Pre period.		Irradiation-period.	
Intake ..		4·98		5·27		8·38		8·38		6·55		6·53
Output—												
Fæces	3·97		3·85		8·41		8·24		6·20		5·80	
Urine	0·21		0·20		0·09		0·09		0·29		0·30	
Milk	1·04		1·07		0·29		0·25		0·30		0·44	
Total		5·22		5·11		8·79		8·58		6·80		8·54
Balance		−0·24		0·16		−0·41		−0·20		−0·26		−0·01

Again the change is due to a diminished excretion in the fæces.

The effect, if any, on the milk yield, has been very indefinite. In one or two of the experiments, however, there is a hint that the composition of the milk may be influenced by irradiation of the animal. This is a question which we are at present investigating.

I have endeavoured to present in the briefest outline an account of the experimental results we have obtained, without burdening it with theoretical considerations. Mention must be made of the fact, however, that many suppose that ultra-violet light acts by economising or synthesising certain vitamins in the animal organism. Steenbock and Black have shown that anti-rachitic properties may be conferred on certain foodstuffs if these are irradiated, but the nature of the chemical changes—if chemical changes in the ordinary sense of the term do occur—are only in process of being worked out.

Apart from its anti-rachitic influence, the general tonic effect of ultra-violet light has led to its being regarded by some as a panacea and by others, therefore, with suspicion There seems no doubt that actino-therapy is a double-edged weapon. Apart from the danger of overdosing, and the production of painful erythema as commonly seen in severe sun-burn, there seem to be certain ill-defined cases in which irradiation has a detrimental effect. Colbrook has reported a few of this type. In these the bactericidal power of the blood, which is in general markedly increased by irradiation, actually fell. A possible parallel may be found in the case of the two pigs whose graph is shown in the figure. It will be seen that following immediately on irradiation there was a marked fall in the balance. Again, near the end of the experiment we irradiated the control pig, whose condition was then

far from satisfactory. The result was a further fall in the balances and a rapid decline in the pig's condition.

To draw attention to such cases, however, is not to detract from the importance of the new weapon that has been placed in the hands of the medical man and the agriculturist. Further, it seems almost unthinkable that animals should suffer from an excess of sunlight in our climate, while it is certain that many animals suffer from the effects of too little. It is not so very long ago since a dark, badly ventilated, and even dirty cow-shed was thought to be good enough for a cow. Our conceptions of cleanliness and of adequate ventilation are very different from those of yesterday, but there is a wide field for advance where the question of light, and particularly ultra-violet light, is concerned. The fact that the latter, from an artificial source or from a free natural source, has such a profound effect upon calcium and phosphorus metabolism, and upon the general resistance of the organism to disease, suggests unlimited applications in the rearing of stock as well as in human medicine. For there seems no doubt that such diseases as rickets, surgical tuberculosis, and many ill-defined conditions of malnutrition are to a large extent, what they have been termed, "diseases of darkness."

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FARM PESTS—BIRDS.[1]

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BIRDS AND GRAIN CROPS (*concluded*).

Wild Duck.—The Common Wild Duck or Mallard (*Anas boscas*) is the most abundant of British ducks, and perhaps that is why it is the only one against which the farmer has complaint to make. Fortunately the damage, so far as corn crops are concerned, is limited in extent and is confined to a short season. During the breeding time, when the nest of the mallard is to be found throughout the country, hidden in the thick undergrowth of woods or hedgerows, in long grass or heather, and generally in the neighbourhood of water, the birds feed upon the animal and vegetable content of the mud which they pass through the sifting apparatus of their bills, upon insects, slugs, snails, grass, leaves of weeds and

[1] Articles in this series, dealing with Mammal Pests, commenced in the JOURNAL in July 1922. The first article on Bird Pests appeared in January 1924.

such like—a thorough miscellany of plant and animal matter. While from autumn to spring, when the numbers of the indwelling individuals, a few of which migrate abroad, are hugely swollen by flocks of immigrants from Northern Europe, they congregate on the sandy shores or muddy flats of estuaries or upon reedy inland lochs. There they subsist mainly upon the food of the waters, devouring even cockles and other shell-fish to be had without recourse to diving, at which they are poor performers.

Wild duck feed from dusk till dawn, and if they leave the aquatic haunts where they have reposed during the day they fly inland in companies, which pitch upon a suitable feeding ground, as often as not a cultivated field. They do little harm here, except in autumn, when they fall upon the stooks. Although they "flight" in small parties, these unite to form a considerable company in the selected field, for even a small loch may yield its two or three score birds; and the mass-feeding which results is responsible for the very considerable amount of damage to grain that may happen during the period between cutting and leading. After the fields are bare of crop they are still visited by the ducks for the sake of the grain in the stubble.

It is only fair to the alien mallards to add that they arrive in this country from mid-September to the end of the first week in November, so that although in a late season they may play a serious enough part, in normal years the greater share of the damage must be attributed to native birds.

Complaints regarding the destructiveness of wild ducks have been made to the Board of Agriculture for Scotland from three Scottish counties, Caithness, Perth and Dumfries, but this by no means covers the area of their transgressions, for they may be harmful in any district within range of their autumn congregating places, by the sea or inland.

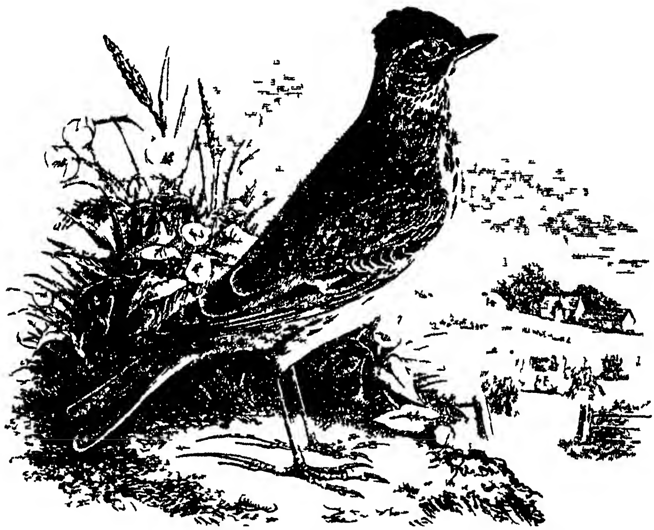
Casual Destruction of Seed corn.—I have endeavoured to show that a number of birds, which cannot be said to be typically grain eaters, are enticed by the favourable opportunity offered by grain in stook to become for the time being grain destroyers. There are a very few typically non-graminivorous birds which are led astray by another favourable opportunity of obtaining food presented to them by the farmer, at the time of the spring and autumn sowings. The culprits include only the skylark, the starling, and, with a big query, the moorhen.

The Skylark.—One of the generally distributed and most beloved of British birds, the skylark (*Alauda arvensis*), is to be found in summer nesting in almost any area of open country, for it avoids closely wooded districts. Many frequent upland moors, but the majority are to be found on grass-covered dunes by the sea, or in meadows and arable land. Scattered in pairs during the summer, in winter they congregate into flocks which move about the fields or take to flight in straggling groups.

In the air the skylark distinguishes itself by its flowing song and by the great circles by which it mounts so easily and rapidly into the heavens, and when in winter the "silver chain of sound" is reduced to a short but still soft and melodious trickle, the bird's flight is still characteristic. The lark now rises suddenly from the

ground and, no longer mounting in the air, flies strongly in a slightly up and down course, the irregularity of which is due to the alternation of a short period of rapid wing-beats with a period when the wings are closed. On the ground it is recognised by its warm brown colour above, whitish underparts with spotted throat, the white outer edges of the tail, the slight crest, and the very long and straight hind claw. Its movement also is characteristic, for in feeding or when disturbed it runs rapidly along the ground, instead of hopping like most other birds.

The nest, of dry grass lined with finer grasses, is built in the shelter of a clump of grass on the ground, in a hollow made either by the bird or more often by the hoof of a horse or cow. The eggs, three to five in number, are closely mottled with olive brown upon a greyish ground. The young hatch about May, and a second brood often follows.



SKYLARK.[1]

The diet of the skylark is a miscellaneous one, as must almost necessarily be the case with an insectivorous bird which remains in Britain throughout the winter. In summer it subsists mainly upon insects, large numbers of beetles, including the turnip flea-beetle and wireworms, of green-flies, of the caterpillars of moths and the grubs of two-winged flies, as well as small earthworms, millipedes and spiders having been found in its stomach In winter, when insects disappear, it turns to vegetable food, particularly the seeds of weeds, such as chickweed, charlock, sow-thistle, sorrel, knotgrass, dock and spurrey.

Did it confine itself to such food the skylark would have escaped comment here, but unfortunately it shows a pronounced liking for newly-sown grain crops. Not only does it pick up the seeds of oats at the spring sowing and of wheat in spring and autumn, but after the grain has sprouted it plucks and devours

[1] The figures here shown are from Saunders' *Manual of British Birds*, by courtesy of the publishers, Messrs. Gurney and Jackson

the tender shoot. Its fondness for tender green leaves is very marked and leads it to attack other seedling crops, to which reference will be made in the section dealing with birds and green crops.

It might be supposed that the number of skylarks in Britain is not sufficient to cause any appreciable damage to the crops they feed upon, and were the damage confined to native birds the supposition would probably be correct. But the skylark population of Britain is subject to a series of incomings and outgoings more complicated than those of most other birds, and having a distinct influence upon its economic standing.

The movements of birds of passage from northern and central Europe to warmer climes, and the emigration of a section of the native-bred skylarks hardly concern us, for the former are passing phases mostly restricted to coastal districts, while the latter only help to reduce to moderate dimensions the numbers of native birds, multiplied by the hatching of double and sometimes triple broods. But local movements of home birds are of importance, since the approach of cold weather in autumn concentrates the summer-time population of the uplands in the more sheltered cultivated areas. Still more important is the influx of winter visitors which have travelled westwards from central Europe or south-westwards from Scandinavia. The former settle in England from the Channel to the Midlands, the latter, landing chiefly on the north and east coasts of Scotland, spread throughout the land.

In the mass, these immigrations of skylarks, which, given suitable weather, proceed continuously for many days, add immense numbers to the home-staying stock, so that during November Britain has to support more skylarks than at any other time of the year. These are the birds which are mainly responsible for the destruction of winter wheat, they arrive in good time for the sowing, from mid-September onwards till the end of October, and the laggards are in time for the sprouting corn. Further, the majority of the immigrants belong to the central European contingent, and it is where they settle most densely, particularly in the southern midlands of England and southwards, that complaints are most rife regarding the destruction of wheat

The winter visitors leave Britain for their continental homes from mid-February till the end of March, according to the suitability of the season, an early departure which relieves the spring sowings to some extent from their depredations.

Although it must be admitted that the skylark does a considerable amount of damage, most serious in a rather restricted area in southern England, it would be wrong wholly to condemn the bird on this account. Indeed all observers are agreed that throughout the year the benefits conferred on the farmer, through the destruction of noxious insects and of weed-seeds, far exceed the limited losses. A study of the relationship between migration and depredations shows that the hordes of skylarks which descend upon the autumn sowing might be thinned of their numbers without untoward results. Such destruction would scarcely affect the breeding stock of Britain, which ought to be preserved, not only for the good it does, but for the pleasure it adds to the countryside.

The Starling.—The history of the Starling (*Sturnus vulgaris*) in Britain is intimately linked with its agricultural importance. Less than a century ago it was a rare bird in Britain, though in the outer isles of Scotland it had dwelt in abundance from time immemorial. Since the forties of last century, however, when in most districts the bird was a great rarity, it has rapidly colonised Scotland, so that nowadays it is one of our commonest birds the year round. Its increase was partly due to the abundance of food offered to it by an improving cultivation of the soil, for its most marked expanse corresponds with the period, beginning in 1853, which Mr. R. Prothero (Lord Ernle) has described as the "golden

THE COMMON STARLING

age" of British agriculture. But probably the ousting of superabundant numbers from overstocked continental areas, and the protection given to birds in Britain since 1880, have also contributed to one of the most outstanding changes of recent years in the bird population of this country

One of the few British birds whose feathers possess a metallic sheen, the starling's shining black coat with purple steel-blue or green reflections, even though they be dimmed and spotted in winter by the buff tips of the feathers, infallibly picks it out amongst its kind. Its song, full of gurgles and clicks, often punctuated by phrases picked up from other birds or even from the noises of the street, is as characteristic as its appearance. The

length of the adult is 8½ inches, its bill is yellow in summer, dark brown in winter, and the young, commencing life in a sombre brown, become spotted in their first autumn, and gradually assume the full colours of maturity. The starling builds a rude nest of straw with a softer lining, pitching it in any convenient hole in tree or wall, chimney or house-eaves, indeed, anywhere. In very open winters nesting may begin with the New Year, but as a rule the pale blue eggs, five to seven in number, are laid in April. There is often a second brood.

The sociability of the starling has much to do with its economic standing. It is at all times a social and gregarious species, but while during the nesting season the flocks consist only of unmated or immature birds, as soon as the young are able to fend for themselves (and that is almost as soon as they leave the nest) the dispersed pairs of parents gather into great flocks which feed together, perform their aerial exercises together, and roost together. To this habit of concentration must be attributed much of the value and much of the harmfulness of the starling, for if their armies may make short work of the beetles or caterpillars on a green crop or wireworms and leather-jackets in a pasture, they may equally make short work of the grain in a corn field.

There can be no doubt that the starling is predominantly insectivorous, and that it destroys insects to the great advantage of the farmer. During the nesting season the young are fed almost wholly on such fare as beetles and their larvæ including wireworms, moths and their caterpillars including such as the yellow underwing, larvæ of daddy-long-legs, many slugs and snails, spiders and earthworms Their voracious appetites must account for a very notable slaughter of many pests. The adults devour many beetles, including such injurious species as the weevils of peas, beans and clover, click beetles and their wireworm larvæ ; many lepidopterous larvæ, including those of the great yellow underwing and the dark-arches moth ; many larvæ of two-winged flies, such as "the grub" or leather-jacket ; many harmful snails and slugs, and occasional centipedes and millipedes, earwigs, earthworms, and slaters or wood-lice.

Curiously enough the insect-destruction is not, like that of most insectivorous birds, confined to the open months of the year. The statistics which have been collected, notably by Mr. F. V. Theobald and Mr. W. M'Gowan, who examined the stomach contents of 748 birds,[1] show that almost as much insect food is eaten during the winter months as at other seasons. This successful winter hunting is probably due to the fine adaptation of the starling's bill, which, strong and sharp, is admirably fitted for probing even hard soil or investigating tussocks in search of hidden larvæ.

In addition to insect food the starling takes a limited amount of weed-seeds, the investigators just mentioned having found within it occasional seeds of spurrey, knotgrass, goosefoot, sheep's sorrel, spear thistle, buttercup, birds'-foot trefoil and chickweed.

Consideration of such vegetable food leads us by a gentle stage

[1] "The Food of the Rook, Starling and Chaffinch," in *Supplement to the Journal of the Board of Agriculture*, May 1916.

to the starling's unfortunate habit of grain stealing. The monthly summaries of Messrs. Theobald and M'Gowan in the paper referred to, which afford far more satisfactory evidence for analysis than slumped totals of the year's feeding, show that no charge can be brought against the starling of eating corn in the ear. During the months from April to September inclusive in 1913, 94 birds examined contained not a single grain, and during the same period in 1912, 251 birds contained 193 grains, less than ¾ grain apiece, a negligible quantity.

But if the grain content of the months of spring and autumn sowing is similarly analysed, a contrast is apparent. February and March of 1912 showed 388 grains for 106 birds, an average of close on 4 grains each; while November yielded the highest average of any month (with the exception of December 1912)—119 grains for 14 birds in 1912 and 25 for two birds in 1913, averages of eight and 12·5 respectively.

The numbers are suspicious. It may be that some of the autumn grain was picked from the stubble (unfortunately the authors do not indicate where each bird was shot), but the known fact that starlings devour newly sown wheat and oats, leads one to believe that the grains enumerated were gathered from the seedbed. They indicate that more damage is done to winter sown wheat than to spring sowings. The destruction thus caused may be serious enough in view of the starling's habit of congregating in great flocks. Dr. Collinge[1] quotes an interesting letter bearing on this point which he received from Mr. R. C. Thomas of Bloxwich, who in November 1912 forwarded to him a starling which contained "37 grains of wheat and many bits of grains, remains of three earthworms, remains of one beetle, and a little grit":—"The field of wheat from which the bird was shot has been visited by great numbers of starlings, and I think I shall be well within the mark in estimating the flock at times at 100,000 units; now, if each bird took 37 grains in one day, they would practically take the seed sown on 2 acres of land. I am quite sure that if they were allowed they would soon ruin the field of wheat in question, and I am afraid they have done a considerable amount of damage, notwithstanding care exercised to keep them away."

Do the migrations of the starling help to account for the damage to newly-sown grain? From late July till mid-September many of our native birds leave Britain, either for our milder Western Isles or for the continent of Europe. But the numbers of the emigrants are more than replaced by hordes of immigrants which reach England from central Europe from late September to the end of October, and Scotland from north-western Europe from mid-October till mid-November. It will be seen that many of these aliens, on the look-out for feeding grounds, arrive before the period of autumn sowing of wheat, and it is highly probable that the greater part of the harm done to that crop is caused by them rather than by British-bred birds.

In spite of the great benefit to agriculture which accrues from the major part of the activities of the starling, little harm can

[1] "The Food of some British Birds," 1913, p. 47.

follow from the destruction of the autumn marauders, provided the farmer realises that the birds he kills would probably have spent the rest of their five months' sojourn in this country in the active hunt for and destruction of injurious insects which he could well dispense with.

The continental starlings forsake Britain for central Europe in late February and in March, and for north-eastern Europe in March and April, and before they have gone the true British birds have returned to our islands from their winter quarters. To what extent the damage to spring sown wheat and oats should be allocated between the natives and the foreigners I do not know.

The Moorhen.—The moorhen or waterhen (*Gallinula chloropus*), a British resident species, frequents the banks of lakes, ponds and rivers, where it builds its nest usually amongst reeds. It is characterised among its relatives, the rails and crakes, by its vermilion bill with yellow tip, and the bright red fleshy frontal shield which decorates its forehead. It is said that on occasion the waterhen will pick up seed-corn, and that a slight loss on this account may occur where it is abundant, even that it may visit the farmyard in search of grain. But the evidence against it is neither abundant nor very definite, and it is undoubted that its main food consists of aquatic insects and crustacea, of slugs, snails and land insects. The moorhen may be looked upon as an inoffensive neutral.

FARM IMPLEMENTS IN SCOTLAND:
HISTORICAL NOTES.

Professor J. A. Scott Watson, M.C., B.Sc., Oxford University.

II.—Eighteenth Century Improvements.

The first notable step in the improvement of Scottish farm implements was the introduction of the winnowing machine or fanners, which occurred in 1710. In that year James Meikle, a wright, was sent by Fletcher of Saltoun to Holland to study the construction of the mill which was there in use for making pot or pearl barley. The original agreement, which was reprinted in the *Farmers' Magazine* for 1800, is worth quoting.

ARTICLES of AGREEMENT between Henry Fletcher and James Meikle.

It is agreed betwixt Henry Fletcher, brother to the Laird of Salton, on the one part, in the name of his said brother, and taking burden upon him for the said Laird of Salton, and James Meikle, wright in Wester Keith, on the other part, that they shall keep and perform to one another, according to the tenor of the following articles, viz. :—

1. That the said James Meikle shall go to Holland with the first fleet that sails thither, after the date of this presents, and learn there the perfect art of sheeling barley, both that which is called French barley and that which is called Pearl barley, and how to accommodate, order, and erect mills for that purpose, in so far as he can, with his uttermost industry, and recommendations given him.

2. That as soon as the said James Meikle shall find himself sufficiently

instructed in said art, he shall return with the first fleet or man-of-war he can have safe passage in, for Scotland or Newcastle. That in the mean time, if he shall be forced to wait, he shall endeavour to instruct himself in any other useful trade or manufactory.

3. That when he returns to Scotland, he shall be obliged to communicate the arts he has learned to Salton, or any whom he shall appoint, and shall communicate them to no other person, but by Salton's permission.

4. That Salton shall pay all the said James Meikle's expences in going and coming, and in learning said arts.

5. That the said James Meikle shall be master of the sheeling mill, if he think fit, and shall have a proportional allowance for it, according to the profit it yields, or a yearly salary, according as two honest men chosen for that end shall determine. But if the said James Meikle shall not think fit to employ himself in this manner, but can do better otherwise, then he shall be obliged to teach the art of sheeling French barley and Pearl barley to any whom Salton appoints, he being paid for the time he employs therein. And besides, in this case, Salton shall give him a handsome reward for the pains he has been at, and the art he has taught, he then going out of Salton's service, and not profiting any more by the mill. And then the said Meikle shall renew his obligation not to make use of this art himself, nor teach it to any other.

6. That if it shall happen that the said James Meikle shall be taken prisoner, either going or coming, Salton shall be obliged to relieve him, and pay all his expences.

7. That if it shall happen that the said James Meikle shall die abroad in this voyage, then Salton shall be obliged to give his wife and children 100 merks (£5).

8. That the said James Meikle, from the time he parts from his own house to go to the ships, till he return, shall be allowed every day two shillings Sterling; to wit, one shilling for his entertainment, and one shilling for his work, and shall give a receipt for any money he gets with him, or any letter of credit he gets, and account for them accordingly when he comes back.

Both parties oblige themselves to keep the foresaid articles, under the penalty of 500 merks, by and attour performance. In witness whereof, they have subscribed thir presents, written by the said Henry Fletcher at Salton, this 17th of April 1710.

(Signed) H. FLETCHER.
JA. MEIKLE.

Meikle duly returned with plans and materials for a barley mill, which was erected at Saltoun, and remained for a good many years the only machine of its kind in the country. The fanner, of course, formed part of the barley mill, but was also in use in Holland as a separate machine, having according to tradition been introduced to that country from the Dutch East Indies. In any case Meikle constructed a set of fanners for winnowing grain, and the original set was kept at Saltoun Mill for nearly a century. Like other agricultural novelties in those early days, fanners were received with a considerable amount of suspicion, and were only slowly adopted throughout the country generally. One objection to their use, which seems to have been urged in all seriousness, was that this was contrary to the divine will; the scriptures said "the wind bloweth whither it listeth," and any attempt to control its course betrayed a want of trust in providence; the fanner must, therefore, be regarded as an infernal machine, and the wind that it produced as "deil's wind." It was not until about 1760 that this implement came into general use.

Improvement of the Plough.—During the eighteenth century several new principles were applied to the construction of the plough, and by 1800 a type not unlike some of our modern forms

had been evolved. Four separate improvements may be noted. Firstly, there was the introduction of the feathered sock, by whose means the furrow slice was partly separated on its under side by cutting, instead of being torn up by the wrest, as happened with the old Scots plough; secondly, there was the alteration of the mould board from the practically straight form of the old plough to a carefully calculated curvature; thirdly, there was the abandonment of wood in favour of iron for the mould board and later for the other working parts; and lastly, as more skill and care were applied to the construction, a material reduction in weight was attained without much, if any, loss of strength.

The first plough embodying any of these new principles was introduced from the North of England and was known as the Rotherham plough. It appears to have been to some extent a copy of a Dutch model, and was first constructed by a certain Mr. Joseph Foljambe of Eastwood in the West Riding, who took out a patent for it in 1720. He charged a royalty of 2*s*. 6*d*. for

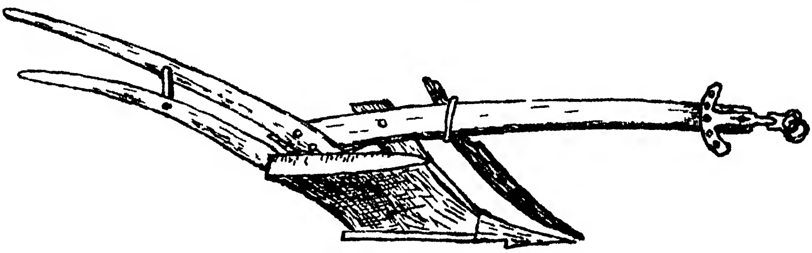


FIG. 1*a* THE ROTHERHAM PLOUGH

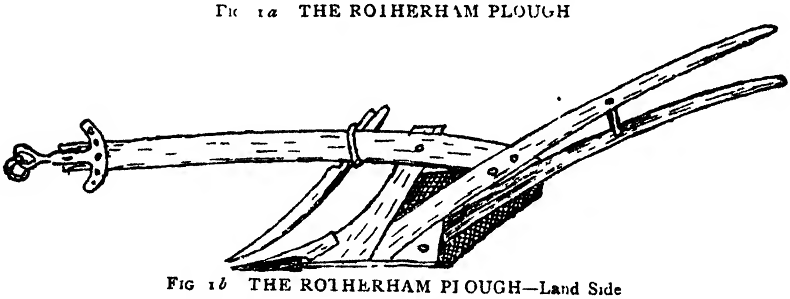


FIG. 1*b* THE ROTHERHAM PLOUGH—Land Side

each plough constructed according to his plans, "but afterwards, attempting to raise the premium to 7*s*. 6*d*., the validity of the patent was combated and set aside, on the ground of its not being a new invention, but only a plough improved." The Rotherham plough was introduced into Scotland in 1730 by an itinerant ploughwright named Lummis, and is figured and described in Maxwell's *Select Transactions of the Society of Improvers of Agriculture in Scotland* (1743). It was also manufactured by a Mr. Dalziel at New Liston in West Lothian, who had been sent to England by the Earl of Stair "in order that he might learn the most improved method of constructing ploughs and other husbandry implements."

The Rotherham plough (fig. 1) was a light and neatly constructed implement, weighing only 1¼ cwt., with a beam only 6 feet in length; the sock was feathered, and the mould board, which was cut from a thick block of wood, had its working surface

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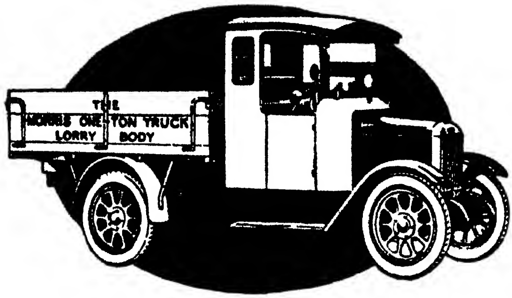

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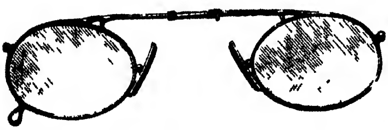

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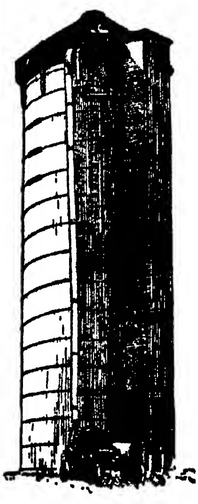

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curved. In later models both the mould board and sole were covered with thin iron plating.

In its original form this plough never became generally known, and, except in one or two small districts, it failed to displace the old Scots type.

Small's Plough.—The chief credit for the improvement of the plough in Scotland undoubtedly belongs to James Small, who was born at Upsetlington, in the Parish of Ladykirk, Berwickshire, about the year 1740. He was a farmer's son, and after serving an apprenticeship with a wright and ploughmaker at Hutton in Berwickshire, he went to Doncaster, where he worked for some years as a wheel-wright and wagon builder. In 1763 he settled at Blackadder Mount in Berwickshire as an agricultural implement maker, and at the same time took a farm of considerable size.

There is no doubt that Small was familiar with the construction of the Rotherham plough and that he adopted some of its features. But in the main Small's plough was evolved by himself by means of long continued and careful experiments. Making a mould board of soft wood, which readily showed the effects of friction, and attaching a spring balance in order to record the draught, he gradually altered one feature after another of his original design until he felt satisfied. At first he worked in wood,

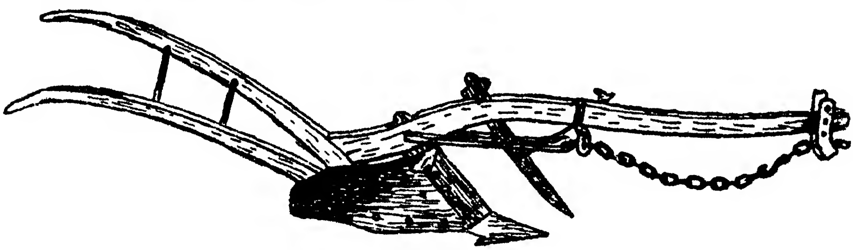


FIG. 2 SMALL'S PLOUGH.

but in 1780 he went to Carron with patterns of the mould board and cheek plate and had them cast in iron. Apart from the obvious advantage gained by the change of material, this enabled the designs of the more important parts to be standardised and made independent of the skill of the country plough-wright. Some years later cast iron was introduced for the "sheath" and "head" as well, wood being retained only for the beam and stilts.

Like other early improvers, Small had to face plenty of prejudice and opposition, and often found it necessary, in order to demonstrate the qualities of his plough, to go into the field himself and take his place between the stilts.

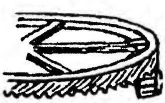
After he had succeeded in getting his plough established in Berwickshire he went further afield, and, in response to a challenge which he issued, the Dalkeith Farming Society arranged a ploughing competition which took place before a large assembly of farmers. The result was a triumph for Small, the judges unanimously deciding that his plough did better work than the old type. Moreover, it was proved that the draught was only 9½ cwt. as against 16 cwt. required for the old Scots plough.

The chain, which is shown in the illustration of Small's plough (fig. 2), was originally introduced in order to allow of the use of a

lighter beam, but was ultimately abandoned as unnecessary. After 1880 Small's plough came into wide general use, and of course led to an immense saving in the cost of tillage. A pair of horses and a ploughman replaced the cumbrous plough teams of the earlier part of the century, and the work was better and more speedily done.

In 1774 Small published a *Treatise on Ploughs and Wheeled Carriages* in which he gave a "distinct and scientific account of the principles on which ploughs and wheel carriages should be made." He took out no patents, spent all his profits in further experiments and in travelling about the country to demonstrate the merits of his plough, and lost money by his book. He died in 1793 a poor man.

The Threshing Machine.—Scottish agriculture owes a heavy debt to the Meikle family, for to Andrew, the son of James Meikle mentioned above, is due the credit for the invention of the first really effective threshing mill. Several machines had indeed been built before his day, but most of these broke down at the first trial, and none achieved anything like a permanent success. Moreover, Meikle's machine was different in principle from anything that had gone before



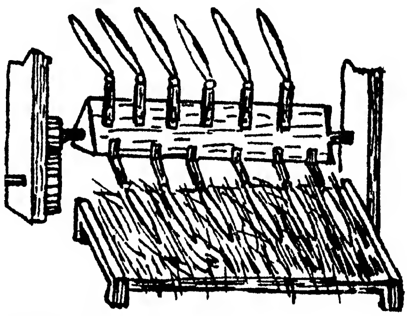


FIG 3 WILLOUGHBY'S THRESHING MACHINE.

The first recorded invention for threshing was a machine built at Roseburn, near Edinburgh, by Mr. Michael Menzies, an Edinburgh advocate, and patented in February 1734. Only a bare record of this invention is enrolled in the Patent Office, and nothing is known about its construction except that it consisted of a series of flails attached to a cylinder which was made to revolve by means of power derived from a water wheel. The Society of Improvers appointed two representatives to inspect this mill, and their favourable report appears in the *Select Transactions* of that body. However, nothing more is heard of it. Another machine on the same principle invented independently at a later date (1792) by a Mr. Willoughby of Bedfordshire (see fig. 3) met with a like fate.

A somewhat more successful machine was built by Michael Stirling, a farmer near Dunblane, about 1758, in which the principle adopted was that of the flax mill. A perpendicular shaft, carrying four long blades or arms, revolved inside a cylinder of about 8 feet in diameter. The corn was fed through an opening in the top and the grain beaten out by means of the arms or scutchers.

The straw was withdrawn from an opening in the side, while the grain dropped through a riddle, which formed the bottom of the cylinder, to a fanner below. This machine seems to have made tolerably good work in threshing oats, but with wheat or barley it did little more than break off the heads.

About 1772 a Mr. Ilderton, who farmed near Alnwick in Northumberland, built a thresher which worked on the principle of rubbing out the grain, a series of revolving fluted rollers working against a fluted concave, and being kept pressed against the latter by means of springs. This machine performed its work very imperfectly and was soon taken down. It was seen, however, by Sir Francis Kinloch of Gilmerton in East Lothian, who caused a model of it to be made. This gentleman, in the course of the same tour, found another thresher in existence at Wark in North-

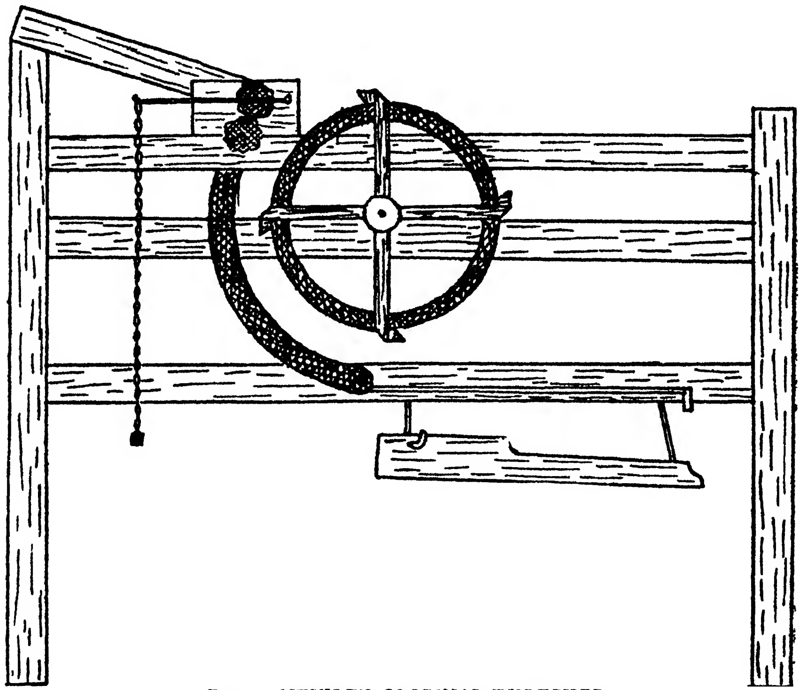


FIG. 4. MEIKLE'S ORIGINAL THRESHER.

umberland and again he secured a model. After a detailed study of these he built a model of his own, embodying certain improvements, and this he took to Andrew Meikle of Houston Mill in order to have it tried by means of the water wheel there. The trial was of short duration, for it is recorded that "in a few minutes the model was torn in pieces," but the incident stimulated Meikle to tackle the problem himself.

Meikle's first thresher appears to have met with no better success than its predecessors, but in 1787 he erected a really satisfactory machine. This was built for a Mr. Stein at Kilbagie in Clackmannanshire, the bargain being that Mr. Stein supplied the materials and that, if the mill failed to give satisfaction, Meikle was to receive nothing for his work. A second mill was erected

immediately afterwards at Middleton in Northumberland, and was so successful that it was immediately copied by various other wrights in the district. Meikle, indeed, took out a patent for his machine, but he seems to have been quite powerless to enforce it, and apparently got nothing by the sale of manufacturing rights.

Fig. 4, which is copied from one of the drawings that accompanied Meikle's specification for his patent, shows a machine of simple construction, consisting essentially of a pair of fluted feed rollers, and a drum revolving inside a concave. The drum carried four beaters with sharp edges, and was made to revolve at some two hundred revolutions per minute. Meikle's original design made

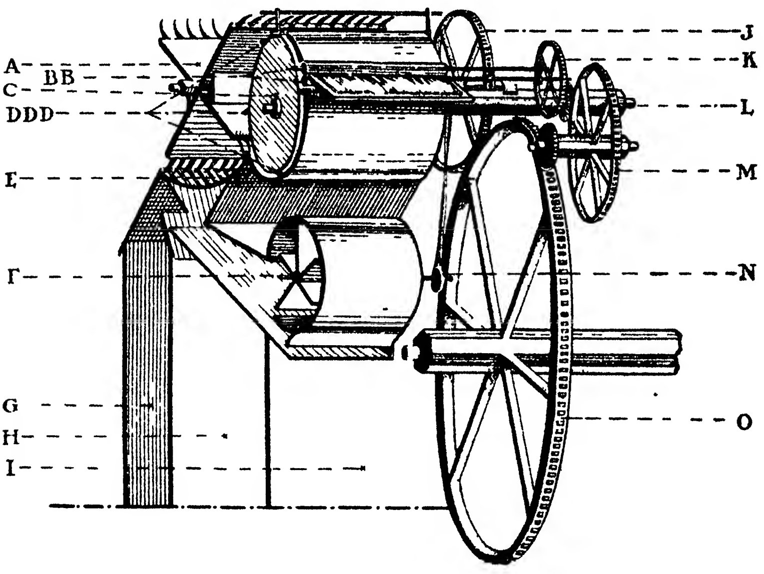


FIG 5. IMPROVED THRESHING MACHINE. From Brown's *Treatise on Agriculture* (1811).

A. Revolving Rake (Shaker).
BB. Fluted Feed Rollers.
C. Drum.
DDD. Beaters.
E. Wire Screen.
F. Fan.
G. Chaff.
H Light Corn.
I Grain
J. Gear Drive for Rake.
K. Gear Drive for Feed Rollers.
L. Drum Shaft
M. High Speed Gearing for Drum.
N Fan Drive.
O Main Gear Wheel.

no provision for separating the straw, chaff and grain; the grain and chaff were shaken out by hand and the latter separated by an independent set of fanners. Very soon afterwards, however, there was added a set of revolving rakes which drew the threshed material over a riddle, and a fanner was placed underneath. The whole arrangement is shown in fig. 5. The modern type of shaker was a much later invention.

Motive power was supplied at first either by a water wheel or by horses. A few windmills were erected about 1800, and between 1815 and 1820 steam engines became common. Transmission

was accomplished entirely by gear wheels, except that the fan had a rope drive.

Like Small, Meikle made little profit by his invention, but a liberal public subscription provided for his old age.

Drill Husbandry.—From about 1760 onwards the practice of drill cultivation began to spread in the South of Scotland—slowly at first, but quite rapidly as the century drew to a close. Long before this time (in 1733) the advantages of drilling and of summer tillage had been urged by Jethro Tull, who had invented quite an effective drill as well as a horse-hoe. That Tull's system was not more rapidly adopted is not really a matter for surprise, for among other things he recommended that the rows of wheat should be set two feet and those of turnips six feet apart. Moreover, he held exaggerated notions as to the function of summer cultivation, and argued that if this were efficiently carried out manuring would be quite unnecessary. Gradually, however, it began to be realised that certain crops, notably turnips and potatoes, and to a less extent beans, could be very successfully grown on a modification of Tull's plan, and that all the essential advantages of his system could be secured by growing a drilled crop at intervals of four or five years.

At first the practice was carried on without the aid of special implements. Ridges for potatoes and turnips were formed with the ordinary plough (both "one bout" and "two bout" ridges being mentioned); beans were sown by hand in every third furrow; and turnips were sown with the aid of a small tin "like a pepper-castor, but with only one hole in the top." But gradually one implement after another was introduced or improvised, *e.g.* hand seed-barrows for sowing turnips and beans, and later horse-drawn implements for the same purposes. Double mould-board ploughs and horse-hoes begin to be mentioned just at the close of the century. In Scotland the drilling of grain crops (the advantages of which are perhaps still arguable) was not adopted, except on an experimental scale, until much later.

To Jethro Tull and to England belong the credit for the invention of the drill and for the essential idea of drill husbandry. But it was in Scotland that the practical application of Tull's system was first worked out, and that Tull's aim of "clean farming without fallows" was first realised.

Other Improvements.—Among a host of minor improvements that were introduced during the second half of the eighteenth century, a new type of harrow perhaps deserves mention. About 1750 Mr. Low of Gordonbank, Berwickshire, conceived the idea of giving the harrow a rhomboidal instead of a rectangular form, and thus secured the main object of distributing the lines evenly over the width of the implement. Old sets of such rhomboidal harrows are still occasionally to be found in use. The modern zig-zag type was invented and patented by Armstrong in 1839.

At the close of the eighteenth century Scottish agriculture was at the beginning of a period of very rapid improvement. Far more important than any individual invention was the change that had taken place in the circumstances of the tenant farmers. At last there was some security of life and property, and even in

many cases security of tenure in the form of long leases. Trade and manufactures were growing rapidly, creating new markets for farm produce, and from 1790 onwards the Napoleonic Wars raised prices to a level that left a wide margin of profit. With money to spend, and the prospect of an ample return, farmers did not hesitate to invest freely in improvements; and along with the erection of buildings and fences and the liming and draining of the land, there came a great change in the general character of the implements that were used. Formerly their cheapness had been the only merit of many of the farmer's tools, thenceforward efficiency became the chief consideration. Well-built carts, iron ploughs and a variety of other things ceased to be a monopoly of a few rich improving landlords, and came to be regarded as part of the standard equipment of every farm.

THE APPLE FRUIT MOTH OR "MINER."

(*Argyresthia conjugella*, Zeller.)

R. STEWART M'DOUGALL, M.A., D.Sc.

ONE of the features of the past season's work with insects has been an attack on Apple Fruit, over an extended area in the north and north-east of Scotland, by the caterpillars of this moth. My attention was first drawn to the insect in examining some apples submitted to me, for determination of the attacking insect, by Mrs. N. L. Alcock, Mycologist to the Board of Agriculture for Scotland. These apples had come from the north of Scotland, and Mrs. Alcock had apples, similarly damaged, from an Argyllshire orchard, 'the greater part of the fruit being nearly useless." This attack by the *Argyresthia* caterpillars is interesting as the first recorded from Scotland on apples. Later a correspondent sent me apples from County Antrim, and on examination of these the same enemy was found at work. This is, I believe, the first record of such damage to apples in Ireland.

Mr. Geo. E. Greenhowe, the Lecturer on Horticulture in the North of Scotland College of Agriculture, kindly sent to me at my request a note of his experience with this apple pest over the northern area, as follows:—

> "The *Argyresthia* you have named for us has devastated the apple crop in the Counties of Kincardine, Aberdeen, Banff, Moray, Nairn, Inverness, Ross, Sutherland and Caithness. All the apple-growing districts of these counties up to and including Sutherland (from which county badly affected specimens were sent in) suffered severely, and only a very small number of isolated cases of small gardens where the fruit was unaffected were noted. From Laurencekirk, south and west, it was interesting to note that the pest seemed gradually to fall away, till on the borders of Kincardineshire and Forfarshire several fine crops were seen quite free from attack. Within the area referred to a moderate estimate of the damage done must run into a total of several hundreds of

pounds. All kinds and varieties of apples have been affected, culinary and dessert, late and early, soft and hard kinds all being attacked. Clean and well-cultivated trees as well as neglected specimens were attacked alike. It was interesting to note, however, that whereas bush and standard trees in the open ground of the garden were badly attacked, wall fruit in the same gardens was clean and free from infestation."

To the above counties I can add from correspondence Cromarty and Clackmannan. No complaints came to me from Perthshire or from the Lothians south to the border.

The normal feeding place of the *Argyresthia conjugella* caterpillar is the "berry" of the rowan or mountain ash (*Pyrus aucuparia*) and not apple—concerning this I shall say more later—and the adult moth, the parent of the caterpillars, has been known for a number of years, as flying about rowan trees in summer, from the south of England to the Caledonian Canal. I think it is possible that Sutherland and Caithness are new records for the northerly distribution of the species.

History as an Apple Pest.—*Argyresthia conjugella* was first named by Zeller in 1859. Perhaps it spread from Europe, in commerce, to Canada and the United States. It is also an enemy of apples in Japan, where it is now one of the most troublesome of fruit pests. Along with some other fruit moths, either new to the United States or not yet common there, our species is aimed at in the United States legislation forbidding entry of stocks, scions, cuttings or parts of the plant likely to harbour such enemies.

A search through the literature of *Argyresthia conjugella* attack, on apples, has yielded the following records;—Sweden in 1875; severe damage in Japan in 1891 and since: British Columbia in 1896; Finland 1898; Devonshire in 1898, when Warburton[1] had specimens of fruit characteristically mined; Norway 1904; Sweden, severe damage in 1908 and 1909; South Devon in 1911, in specimens recorded by Theobald[2]; Cumberland in 1911, recorded by Britten; North and Central Russia in 1913, the damage being worse than that of the Codlin Moth caterpillars; Sweden in 1916; Denmark, serious damage in 1919; Holland in 1920; North Germany—many varieties—in 1921.

Systematic position of the Moth.—This moth belongs to the family *Argyresthidæ*, of which there are about 25 British species. The caterpillars of this family feed under cover, i.e. under bark, or inside shoots, or in buds or in fruits. The moths are tiny and delicate, requiring very careful handling if a good specimen be desired.

A. conjugella, the apple fruit moth, is seen in fig. 1 which is a photograph from nature.

Description of Moth.—The head is white and the body brown. Front wings brown or purplish brown; the front margin of the wing shows here and there white spots and marks; near the middle of

[1] Journal of Royal Agricultural Society of England, 1898.

[2] Fred. V. Theobald in Third Report on Economic Zoology, 1911. S. E. Agricultural College, Wye.

this fore-edge and between two white spots is a four-sided brown spot; hind margin of front wings white, with a squarish brown spot near the middle of the hind-edge; hind-edge fringed. Hind wings dark grey; hind-edge with long fringes. The antennæ show alternate brown and white rings; the legs are also brown and white.

Larva.—The larva is a caterpillar with 16 legs, viz. six thoracic and ten abdominal or prolegs, and measures when full grown between a quarter of an inch and a third of an inch. Its general appearance can be gathered from an examination of the magnified drawing in fig. 2. The colour of the caterpillar varies according to its age. I have examined a number of them from quite young caterpillars to full grown ones, and, except for the head and the plates on the first and last joints, three colours can be found. The youngest caterpillars are pale white; the slightly larger caterpillars are dirty-white or whitish-yellow or greyish with a tinge of red, while later and till the end of their life the caterpillars are flesh red. The jointing of the caterpillar is quite distinct, and the redness of the colouration is not quite so marked between the margins of the joints. The head is brown black, and under magnification short three-jointed antennæ can be seen, and on each side of the head six simple eyes The first joint behind the head has two horny plates on its upper surface (only one can be seen in the drawing), the two plates being separated by a line, these plates are not quite so dark as the head. There is also a plate on the upper surface of the last joint not quite reaching the front margin of the joint, and less chitinised than the plate on the first joint. On each side of the first joint is a spiracle and a pair of spiracles on joints four to eleven inclusive. All over the body are yellow hairs each arising from a minute brown to black papilla.

The Cocoon.—The full grown caterpillar spins a double cocoon of silk; the outside cocoon is loose and net-like in structure; the inner cocoon close and firm. The cocoons are white in colour and oblong or spindle-like in shape.

Life-history and Habits.—The moths are found flying round the rowan (see later) or apple in June and July. After pairing, the females, within a week of their emergence, proceed to their egg laying. I have not had an opportunity of seeing the eggs laid, but Matsumura,[1] working in Japan, describes them as being laid on the young apples. The same worker adds that the eggs may be found on the leaves, in which case the caterpillars on hatching have to find the fruit. Lampa[2] describes experiments in Sweden. A female caught on July 19th was put into a glass cylinder containing apples. Next day she was noticed sitting on an apple, her attitude and movements suggesting egg laying, and by night at least six yellow eggs had been laid. On the morning of the 21st ten eggs were counted, nine of them fastened to the calyx end of the apple and one near the stalk of the fruit. On the 29th only six eggs could be seen, on the 30th only one, and on the 31st

[1] *Zool. Mag.*, Tokio, vol. 8, 1896, and the United States Dep. of Agric. Div. Ent. Bull. 10, N.S., 1898.

[2] *Ent Tidskr. Arg.*, 27, 1908.

FIG. 1.—*Argyresthia conjugella* (magnified).

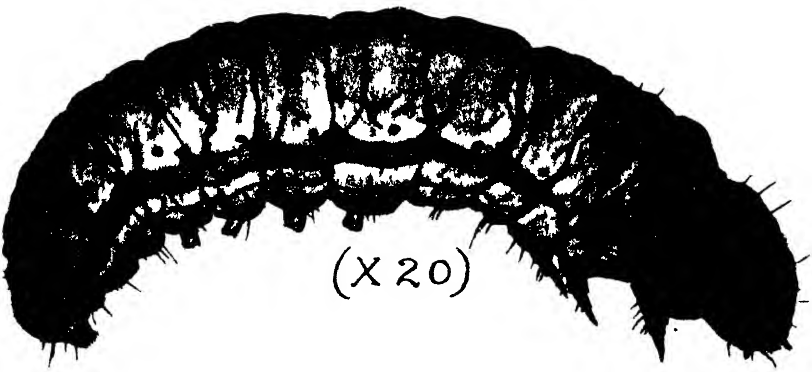


FIG. 2.—Caterpillar of *Argyresthia conjugella*.

FIG. 3.—Apple showing signs of entry of *Argyresthia* Caterpillars. The larger dark marks are due to Apple Scab (*Venturia inæqualis*).

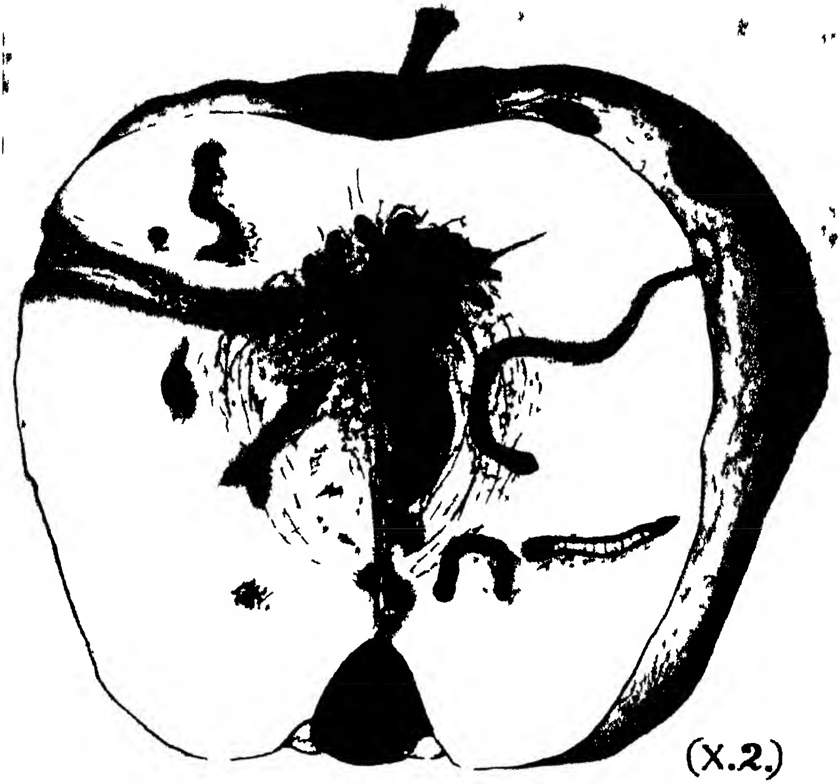


FIG. 4. Section of Apple damaged by *Argyresthia conjugella* showing entrance tunnel on right and exit tunnel on left.

FIG. 5. Apple in section. *Argyresthia conjugella.* Cocoon in situ.

Fig. 6.—Section through damaged Apple, showing two larvæ of *Argyresthia conjugella*

Fig. 7.—Seeds of Apple spoiled by larva of *Argyresthia conjugella*

Fig. 8.—Nature of damage done by Caterpillar of the Codlin Moth

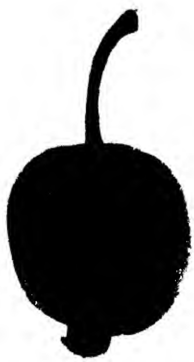


Fig. 9.—Exit hole and damage of larva of Ap Sawfly (*Hoplocampa testudinea*). From natur

none. In place of the eggs small holes were present; the holes were not where the eggs had been seen but were on the sides of the apple The holes represented the places at which the caterpillars had bored into the apple. In the open, one finds the holes all over infested apples That apples have been entered by the caterpillar is indicated by small sunken discoloured spots each with a minute hole in its centre (fig. 3). Later these spots are black. In the great majority of infested apples that reached me this autumn other discoloured spots or patches were numerous, due to apple scab (*Venturia inæqualis*). Reh[1] states that as many as 25 caterpillars have been taken from one apple. The highest number present at one time in my specimens was nine.

The moths are found in flight over an extended period in the summer, and thus there is a chance for apples of all sizes to be attacked. My specimens include examples from the size of a walnut to full-grown apples.

The caterpillar on hatching from the egg enters the flesh of the apple and may feed just under the skin, but what is far more usual a tunnel is eaten out, very fine and narrow to begin with, but increasing in diameter with the growth of the caterpillar. The general work of the caterpillars is shown in fig. 4 The tunnels are towards the centre of the apple but not directly by the shortest road; they wind and twist and are not easy to follow with the complication of numerous other galleries (figs. 5 and 6). The line of the gallery is traceable by a brown discoloration and by the wet frass which fills the gallery or mine behind the feeding caterpillar. Having reached the core of the fruit the caterpillars eat into the pips and hollow these out quite destroying them (fig. 7). The caterpillar is full grown in a month or considerably longer according to the temperature, i.e. the caterpillars from the first-laid eggs earlier in the season complete their growth as a rule in less time than the caterpillars from later-laid eggs.

The full grown caterpillars leave the apple, mining their way to the outside, and then let themselves down to the ground by a spun thread or walk down the stem. They enter the soil or take advantage of any litter or leaves and proceed to spin their double cocoon, in which stage the winter is passed Or the infested apples may fall, carrying the caterpillars with them; in this case the caterpillars leave the apples on the ground and seek a convenient place for their cocoons. Or—and in my own observations with infested apples kept in breeding-cages this happened frequently—the full-fed caterpillars do not leave the apple but spin their cocoons inside the spoiled fruit. These cocoons were sometimes right in the core of the apple (fig. 5), and sometimes towards the calyx end of the apple. In several cases, however, the cocoons were found just below the skin of the apple, an exit hole for the future moth having been first made to the outside; such caterpillars after eating a gallery to the outside spun their cocoons a little way back from the exit. It is clear that this making of the cocoon in the damaged fruit may materially aid in

[1] Reh has written on *Argyresthia conjugella* in two publications which I have not been able to consult, viz. *Prakt Ratg. f Obst.—n. Gartenbau*, 1907, and again in 1908.

the spread of the pest. At the same time it is difficult to understand how moths from the cocoons in the core, and in the flesh with no exit prepared to the outside, can make their way to the open. There must be considerable mortality in such cases; besides the rotting of the apple brings mould in its train and this is fatal to the pupa; a fact proved in my experiments. Caterpillars were found feeding, in the apples that reached me from various sources, right through September and into October.

Varieties attacked.—It has been stated earlier in this paper that all kinds of apple showed infestation. Among those badly attacked in Scotland were Bramley's Seedling, Baillie Nielson, Grenadier, Early Victoria, James Grieve, Worcester Pearmain, Beauty of Bath, Ellison's Orange, Hector Macdonald, Newton Wonder, Red Victoria, The Crab Apple. The experience was a little different in Ireland, my correspondent writing me, "I have in my orchard about 300 trees. Of these all except the 80 Bramley's were diseased, viz. Grenadier, Victoria, Lane's Prince Albert." Lampa, in reference to a severe attack in Sweden some years ago, wrote:—"The small Paradise varieties were more damaged than the rest."

The Rowan and its possible connection with the Apple attack of 1925.—The rowan tree (*Pyrus aucuparia*) and the apple tree (*Pyrus* or *Malus malus*) are both members of the same natural order, *Rosaceæ*, and indeed belong to the same genus *Pyrus*; their fruits, too, are not markedly different. There is no doubt that the fruit of the rowan is the normal feeding place of our *Argyresthia* caterpillar. As a rule an infested rowan berry contains only one caterpillar, which tunnels to the seed. The *A. conjugella* moths are known to be local according to the presence of the rowan. (In Scandinavia, however, infested apples have been found where no rowan was in the immediate vicinity, but the *Argyresthia conjugella* moths can fly and may be carried some distance by wind.) My own belief is that the severe attack on apples this past season has a close relation to and may be explained by the comparative absence of rowan "berries" in 1925. My own observations this summer and autumn assure me that the crop of rowan fruits in Midlothian and East Lothian has been nothing like so abundant as in 1924. Mr. R. L. Harrow of the Royal Botanic Garden informs me that rowan "berries" at the Garden were far less abundant than usual. The theory, then, is that in absence of the normal food, viz. the fruit of the rowan, the moths, numerous because of preceding favourable years for rowans, finding a difficulty in getting the normal fruit for the laying of their eggs, turned their attention to the apple and used it. In support of this view Mr. Greenhowe wrote in reply to me: "The absence of rowan fruits this year over the attacked area has been very noticeable." Again one knows Balmoral and neighbouring northern areas—the areas where the apple fruit moth has done so much damage—as notable places for *Pyrus aucuparia*, and in answer to a query as to the experience as regards rowan "berries" this season, Mr. Robert Chalmers, the King's gardener, wrote, "As regards the rowan, we had no fruit on the trees here at all. I cannot remember any year in

my experience when there was not some rowan fruit." Further, in answer to my query, my Irish correspondent, whose apples were so badly damaged, wrote: "Last year (1924) was an exceptionally good year for rowan berries but this year there have been very few." The suggested relationship between rowan, apple, and caterpillar, receives strong support from experience in Sweden as detailed by Lampa.[1] For example, in Sweden in 1904 rowan fruits were abundant. The years 1902 to 1904 had been favourable years for rowan fruit and in this time the *Argyresthia* caterpillars had increased in number. In 1904 the rowan had been very badly infested by *Argyresthia* and in 1905 there were no rowans. In 1905 the *Argyresthia* moths from June to August were found flying round the rowan trees, but no fruits were present to be used for egg laying, with the result that the moths flew to the neighbouring apple trees. From all parts of Sweden came complaints that the apples had been totally destroyed. A similar happening occurred in Sweden in 1916. In preceding years rowan berries had been plentiful and the *Argyresthia* moths multiplied. In 1916 the rowan inflorescences failed and the apple crop was greatly damaged by *Argyresthia* caterpillars.

Treatment.—Where there has been damage to the apples this season the soil under these trees should be dug so as to expose cocoons. Further, the digging of the ground would result in some direct destruction of cocoons in the litter and in the soil. The tramping down or firming of the soil again would destroy more.

During the months of attack it was a wise measure to collect fallen apples with the caterpillars still in them and to feed them to swine. Apples invaded by the caterpillars fall easily, and a jarring of the trees brings such apples down for collection.

That the rowan fruit is the usual feeding-place of the apple fruit moth caterpillars tends to complicate matters. It were good policy, however, to watch the rowan trees, especially those in the neighbourhood of orchards and gardens. Abundant rowan berries would mean, certainly, to some extent a respite for the apples. Where the rowans were scarce or had failed one might safely forecast trouble to the apple, and in such a case the past season's experience would justify a spraying of the trees with arsenate of lead. A second spraying might be necessary owing to the extended flight time of the moths. The purpose of this lead-arsenate spray is to poison any caterpillars starting to eat their way into the fruit. There is the natural objection to the arsenic on fruit, but a washing or rubbing of the harvested apples would ensure against danger. Where apple scab is also present—as was the case very commonly in the attack described—a combined spray of Bordeaux mixture and arsenate of lead could be used, or in the case of apple varieties sensitive to Bordeaux mixture, e.g. Beauty of Bath and James Grieve, a combined spray of lime sulphur and arsenate of lead. The Bordeaux mixture or the lime sulphur would prevent or check the apple scab fungus, and the arsenate of lead would poison not only *Argyresthia* caterpillars but all caterpillars.

There is room for experimental work in spraying on rowan

[1] *Ent. Tidskr. Arg.*, 27, 1908.

trees, from which guidance might be given for the treatment of *Argyresthia* caterpillars on apple.

Following the conviction of a seller, on whose apples traces of arsenic were found ($\frac{1}{16}$ of a grain per lb.), the danger from apples treated with an arsenical spray has recently been made the subject of a circular by the Ministry of Health. The notice is justifiable because of the poisonous nature of arsenic, but at the same time it is easy to exaggerate the danger. The use of an arsenical spray has been for long in most apple-growing countries a regular part of the culture operations of the year in the war against insect enemies of the apple. In the great majority of cases the spraying has been done early, and all traces of any arsenic have been washed away by rain before the apples have been harvested. It would be safe to say that the great majority of apples that enter Britain from abroad are free from arsenic. Still, where the spraying is late, and especially where, in a dry climate, dusting rather than spraying may be the fashion, there is some risk from adhering arsenic, and it is safer to rub the fruit with a cloth, or to wash it, or later to peel it.

Other Insect Enemies of Apple Fruits.—*Argyresthia conjugella* being a new enemy and its caterpillars not being known, the damage to the apples was ascribed in some places to either the caterpillars of the codlin moth (*Cydia pomonella*) or those of the apple sawfly (*Hoplocampa testudinea*). The caterpillars of all three insects as also their damage are easily distinguishable (figs. 8 and 9).

Codlin Moth Caterpillar.	*Apple Sawfly Caterpillar.*	*Apple Fruit Miner Caterpillar.*
Larva has 16 legs. Pinkish white or cream white.	Larva has 20 legs. Whitish yellow with a dark plate on the last joint.	Larva has 16 legs. Flesh red (when grown), and with a brown plate on the first and last joints.
½ to ¾ inch in length when full grown.	½ inch in length when full grown.	¼ to ⅓ inch when full grown.
Generally enters the apple at the "eye" or calyx end, and makes a gallery right to the core, where it feeds for a time.	Enters at the side of the apple and eats out an irregular cavity in the flesh.	Enters at the side of the apple and makes for the centre, not directly, but by a winding mine; diameter of mine small.
One larva to an apple.	One larva to an apple (a larger apple may hold more than one larva).	Several or many larvæ (double figures) to an apple.

The Apple Maggot.—In the United States and Canada there is a harmful enemy of the apple, the larva of a fly named *Rhagoletis pomonella*. This fly lays eggs in punctures on the skin of the apple; the result is a number of pits or dimples that spoil the appearance of the fruit. The apple maggots, on hatching, tunnel in the fruit.

Reports from the north of Scotland of apples that contained a number of larvæ which made winding galleries that appeared as

brown streaks raised fears in some quarters, before specimens had been received for examination, that the dangerous apple maggot had gained entry to our country. Fortunately it turned out not to be so.

The Apple Maggot is easy to distinguish from the three apple enemies named above. It is a legless maggot, smooth and white, which, when full grown, measures just over a quarter of an inch; the front end is pointed and carries two very small mouth-hooks, the hind end is thicker and blunt; the first joint of the body bears two spiracles visible only on magnification, and on the hind face of the last joint dark-coloured spiracles are present.

The apple maggot fly (*Rhagoletis pomonella*) is one of the pests scheduled by the Ministry of Agriculture and Fisheries and by the Board of Agriculture for Scotland.

THE BIOLOGIST ON THE FARM.—No. XX.

By Professor J. ARTHUR THOMSON, M.A., LL.D.,

Spreading of Earthworm's Parasites.—Whenever the biologist says "earthworms," he knows that he is safely on the farm, and the earthworm is inexhaustible! Dr. Keilin of Cambridge has been inquiring recently into the way in which the parasites that earthworms harbour are spread. There are always Gregarines, and there are frequently larvæ of threadworms (*Pelodera pellio*) in the earthworm's reproductive organs (seminal vesicles) and in other regions of the body. How do the earthworms come to be so heavily infected? Some have suggested that spores of Gregarines may be passed into the cocoon of the earthworms along with the sperms, and may infect the developing earthworm before it emerges from the cocoon But Dr. Keilin points out that the young earthworm in the cocoon, and for some time after it emerges, does not seem to be susceptible to infection.

According to Dr Keilin there are two main ways in which the cysts and spores of Gregarines and the larvæ of Nematodes are liberated from earthworms. First the earthworms may die and their disintegrated bodies may be disseminated in the soil. The contaminated soil eaten by other earthworms is the source of their abundant infection. In the second place, the parasites may be set free by partial autotomy or self-mutilation on the earthworm's part. The parasites are sometimes passed backwards in the body cavity of the earthworm and produce a swelling of the hindmost rings. A stricture appears between this terminal swelling and the rest of the body. It becomes gradually deeper until the parasitised rings become severed from the rest of the worm. The detached part disintegrates, liberating spores of Gregarines and larvæ of Nematodes into the soil, which may be eaten in due course. We do not know how long the parasites can live in the soil. As for the curtailed earthworm, it is relieved of a burden of parasites—not that they seem to be of much account—and it can replace the rings it has lost.

Sharing a Parasite.—In the majority of cases a parasite is characteristic of a particular host. Even in the case of fleas, which we regard as minute beasts of prey rather than as parasites, there is marked specificity. A bat's flea would not live on a mole. No doubt there are many exceptions, such as the liver-fluke, which occurs in a large number of diverse hosts,—sheep, cattle, horses, and a dozen more. But this is unusual.

It is no exception to this "specificity" that different stages of the same parasite are often and normally found in two different hosts. Thus the "sturdie" bladderworm of the sheep gives rise to the *Tænia cœnurus* tapeworms of the dog, just as the bladderworm of measly beef becomes the *Tænia saginata* of man. So far as we know, feeding this bladderworm to dogs has no results. This particular species belongs to cattle and to man in its bladderworm and tapeworm stages.

But here is a recently published case that illustrates what we more particularly mean by sharing a parasite. A little girl in Savoy had a painful swelling behind her ear, and when this was attended to, what should come out but a young larva of a familiar acquaintance—the warble-fly (*Hypoderma bovis*) of cattle. The case has been carefully investigated by Emile André of Geneva and there seems no doubt about it. The fly must have deposited its egg in the skin behind the ear, and the developed larva must have remained stationary instead of migrating hither and thither as it does in cattle.

Toilet Operations among Mammals.—Professor Frederick Wood Jones, D.Sc., F.R.S., the distinguished anatomist of Adelaide University, has published a very instructive lecture on the variety of ways in which wild mammals keep themselves clean. (1) They may rub themselves against external objects, as sheep do. (2) They may flick with their tail, as cattle do. (3) They may scratch with their antlers like stags or with their horns like antelopes. (4) They may twitch their skin muscles, as the horse does, and as many marsupials do. (5) They may lick with their tongue as is so well known in cats, both large and small. The roughness of the tongue, usually interpreted as helping to rasp the flesh off the bones of the victim, is regarded by Wood Jones as a toilet adaptation. Some marsupials lick their fore-limbs and other parts when they are distressed with the heat, thus producing an evaporation surface which cools them down and compensates for the deficiency of sweat-glands. So, as we all know, a dog cools itself by lolling out its tongue. The farm comes in again when we note that if cattle lick themselves or others at the time of coat-casting, they get hair-balls in their stomach, accumulations sometimes strangely calcified.

(6) Combing with the teeth is well illustrated by *Lemur catta*, one of the half-monkeys, and it has a little brush beneath its tongue for cleaning its teeth after the toilet is completed. (7) Some Free-tailed Bats have a brush of strong hairs, recurved at the tip, on the first and fifth toes of the foot, and with these brushes they rake their fur. (8) Sometimes, as in the Lemur called Mongoes, there is combing with nails or claws. The long claw on the second toe of the Spiny Anteater is just suited to scratch down to the roots of the strong spines. Toilet promotes cleanliness, and

cleanliness makes for health; it is interesting to notice the varied ways in which the same end is attained. And, of course, there are other ways.

Individuality.—A valued correspondent, who knows what he is talking about, has sent us a note in regard to a hedgehog which he saw late in November eating a rabbit on the open hill-side. This was in the country somewhat to the north of Aberdeen. Now this kind of record is a little surprising, for though hedgehogs are occasionally seen moving about in December, an Aberdeenshire hedgehog in late November should have been in a state of "winter-sleep" or hibernation. More than that, a hedgehog, zoologically considered, has no business to be eating a rabbit, though that again is not unknown. What our correspondent's letter illustrates is a great fact, that one cannot lay down hard and fast rules for animals, especially for those with brains worthy of the name. For one of the distinguishing features of the living as contrasted with the not-living is the mysterious quality of individuality. Two pebbles may be very different from one another in their chemical and physical characters, but they have no idiosyncrasy. And if you take two pebbles of the same composition, size and weight, what is true of the one will be true of the other. Knowing the one, you know both; but this cannot be said of animals of higher degree. They are *individual*, and individuality implies a certain degree of unpredictability,—as in the case of our hedgehog. It was a queer fellow. In biology one cannot always trust the adage: *Ex uno disce omnes.*

A Hare in the Sea.—Many instances of unpredictable idiosyncrasies will occur to those who are interested in animals. We have seen Black-headed gulls perched on the top-wire of a fence, to which webbed feet cannot be well-adapted. We have known of a cat that had a weakness for cabbage We have seen a bird's nest inside the lamp above the platform at a Deeside station, but of course there was no lighting-up at that time of year. There are hundreds of these "curiosities of Natural History," but one of the strangest stories, which few will believe, is that of a hare swimming out to sea. We can absolutely vouch for this: there was no possibility of mistake. The hare was browsing on some delicate sea-shore plant near high tide-mark; it was surprised by intruders and galloped along the beach, but as the rocks did not favour getting inland, it plunged into the sea and swam round a little promontory into safety.

A Luminous Spider.—Hundreds of different kinds of spiders are known, some like jewels in their colouring, but Mr. Barnum Brown is the first naturalist to report a luminous one, which, unfortunately, he failed to catch. It was in Central Burma in the jungle that he saw, a few feet away, a ball of light as large as a man's thumb. Tying his horse, he advanced cautiously in the darkness through the thorny brush. He struck a match and there in full view was a spider, his large oval abdomen grayish with darker markings. Still he did not move, and as the match flame died out, his abdomen again glowed to full power, a completely oval light, similar in quality to that of fire-flies. Wrapping a handkerchief round one hand, for spiders are poisonous, and

parting the brush with the other, Mr. Barnum Brown made a grab; but the luminous spider was too quick for him, and the treasure was for the time being lost to science. Many nights it was sought for, but all in vain. There is no reason that we know of why a spider should not be luminescent, but Mr. Barnum Brown admits that there are possibilities of error. Thus it may have been eating fire-flies and may have been shining with the borrowed light of their ingested juices. But the light that was observed was a perfect oval. Another possibility is that the spider may have had its surface infected with luminous bacteria or fungi, such as sometimes occur on rotting wood. The relevancy of this story to the farm is that it illustrates the need for scientific caution, and the advisability of first catching your hare. Spiders, moreover, play a useful part in checking the multiplication of insects, but it would be too much to expect that they should confine themselves to the injurious kinds

Cowbird Outwitted.—The North American Cowbird (*Molothrus ater*) used to be the everyday companion of the bison, and when the great herds dwindled away it transferred its attention to the introduced cattle As with starlings in Britain, it picks up the insects which the cattle raise from the ground and also those which are always attracted by a herd Like the European Cuckoo, the Cowbird builds no nest, but utilises that of some other bird. When the young Cowbird is hatched out it does not oust the rightful tenants of the nest as our cuckoo often does, it simply insists on getting all the food that the "duped" foster-parents bring. Thus the other nestlings die of starvation. In a recent article Dr. Charles Macnamara records the interesting fact that the Yellow Warbler (*Dendroica æstiva*) often detects the intruded egg and refuses to accept it. Nests are found that are four or five inches high, instead of the usual three, and the additional height is due to an unusual thickness in the floor. If you probe into this heavy base, you are almost sure to find a cowbird's egg embedded in it. Sometimes there are two. Why the Yellow Warblers do not simply throw the Cowbird's egg out of the nest it is hard to say, but such a procedure would probably mean a greater departure from their usual instinctive routine than the method they pursue of burying the intrusion with roots and grass and the other building materials of the nest.

Our Starling in America—Mr. Frank M. Chapman reports on the prodigious increase of the European Starling in North America. One hundred birds, by extraordinarily short-sighted enthusiasm, were introduced in 1890-91, and these are now represented by millions. From New York City the birds spread along the coastal region, and then began to penetrate the interior. In 1916 they had crossed the Alleghenies, and Mr. Chapman believes that they will surmount the Plains, the Rockies and the Sierras, and establish themselves throughout the greater part of North America. Why should the starling have increased so much when native species have not, it seems, appreciably increased in any single case. The answer must be that the introduction of this alien meant opening up a field not exhaustively exploited. The starling found a niche of opportunity—"an ecological niche"—and prospered accordingly.

Moreover, the starling is hardy, pugnacious, omnivorous and prolific. It often has two broods in the year, and it is very successful in rearing them. What are the pro's and con's of the hospitality that America has extended to the starling? (1) It is a very effective destroyer of cutworms, grasshoppers and weevils, with few equals in the North-eastern United States. In this respect, then, it is highly beneficial. (2) On the other hand, the starling is very destructive of cherries, and to a slight extent it damages other fruits and garden green stuff. In some places the size of the flock is so huge that they drive away other birds and distinctly lessen the amenity of their haunt. On the whole the balance is in the starling's favour in America; and in any case the bird has come to stay.

THE CONTROL OF ONION SMUT.

N. L. ALCOCK, F.L.S., A. E. S. M'INTOSH, and
G. B. WALLACE, Ph.D., B.Sc.

THE disease caused by the fungus *Urocystis cepulæ* and commonly called Onion Smut has been recognised in the United States since 1869. It has been known to exist in Great Britain for the last twelve or possibly fifteen years, but it is probable that it has been in the North of England and the South of Scotland for a good deal longer.

The disease is noticeable soon after the seedling comes up. Long silvery gray or black blisters form within the leaf tissue, running along the leaf, which is often thickened and bent down. Very often the disease is so severe that the young plant dies outright. If the plant continues to grow the stripes grow with the leaves and appear also in the bulb-scales. The plant grows on and presently the stripes split, exposing a powdery sooty mass of the spore balls of fungus. Occasionally a plant entirely outgrows the disease, the leaf originally attacked being shed, but this is rare. In most cases the plant that survives continues to produce leaves and scales with dark stripes, which are silvery black while the outer skin covers the spores and vividly black when the blister, enlarging, splits and shows the spore mass. Occasionally a large specimen may survive and be harvested, but it will show marked raised stripes specially near the base of the bulb, and smut blisters will be found in several of the inner layers as well as on the outer scales. As a rule, however, the attacked plants are small and unthrifty, the large bulbs being few in number and the percentage of loss high. The spores can live a long time in the soil, and each seedling that is killed outright, each diseased leaf that is shed, each blister that bursts and lets escape the mass of sooty black spore balls, contributes to the infection that remains in the contaminated soil.

The fungus remains alive in the soil for many years, and the germinating spore can attack and enter into the young onion while the seedling is at the vulnerable stage (Walker, *Journ. Agric. Res.*, XXII, No. 5, Oct. 1921). This stage lasts about three weeks

or until the plant is about 3 inches high. Transplanted onions, if grown in disease-free soil originally, do not contract the disease when planted out, and transplanting, therefore, forms a useful means of control for garden work. For field work, however, formalin has been found an efficient fungicide.

In the Northern States of America, where at one time the disease threatened to prevent onion growing in many otherwise excellent onion growing lands, the formalin drip has been found to reduce the amount of Onion Smut to an almost negligible quantity.

Trials for the control of Onion Smut have been carried out in England by Mr. T. Whitehead, Advisory Mycologist to Bangor University, North Wales (*Min of Agric. Journ.*, XXXIII, p. 443, 1921), in 1919, and by Mr. E. G. Cooke, Inspector to the Ministry of Agriculture, in 1920. These trials proved the efficacy of the treatment so largely used in America.

It seemed advisable to try the treatment with some variations for a Scottish area, and here I should like to acknowledge the help we have had from Dr. J. C. Walker, Pathologist, Office of Cotton, Truck and Forage Crop Diseases Investigations, Bureau of Plant Industry, Washington, U.S.A.

In the spring of 1925, by the kindness of Messrs. T. A. Scarlett and Messrs. J. and R. L. Scarlett, who rendered valuable assistance throughout, we were enabled to carry out two sets of experiments in the use of formalin in controlling Onion Smut in a Scottish area. An area with diseased leeks was put at our disposal in North Edinburgh, and an area with diseased onions served as an experimental ground in East Lothian The position of the field at Chancelot, so near to the Royal Botanic Garden, was a very great convenience, and it made it possible to carry out the experiment with more frequent visits than at Inveresk.

The field was gently undulating with a slope facing approximately north-east, the portion on which leeks had been grown being about 3 acres. Leeks had been grown there successively for a good many years and Onion Smut was found in all parts of the field, but the most heavily infected land lay at the foot of the slope. The field had been manured with fish manure—15 cwts. per acre.

The experiment was started on April 13th. As a preliminary method, in order to try the disinfectant, we used ordinary two gallon watering cans with a long straight spout. Instead of a rose, a cork was fitted into the mouth of the spout and a notch cut in the cork, so regulated that a gallon would be poured in 60 yards of furrow by a man walking at his ordinary pace. This plan ensures a small single stream of water that could be directed to the bottom of the furrow. In this way a regulated small stream fell into the bottom of the drill in the same manner as the stream would fall from the pipe of the Formaldehyde Drip Attachment used with the onion seeder in America. It is imperative that the stream should fall into the bottom of the furrow, so that the solution should be in close proximity to and soak the soil immediately round the seed.

A stretch of ground 60 yards by 8 yards was selected where

the disease had been very severe. The drills had been marked out 12 inches apart, making 23 rows in all in the plot chosen for the experiment. The plot was divided into two, each 30 yards long by 8 yards wide. One plot was divided into 8 strips, and various strengths and no strengths (i.e. plain water) were applied to the various strips. The other plot was treated with the strong solution—2½ ozs. formalin to 1 gallon water, which was applied all over this patch. This solution is equal to 2 ozs. to an American gallon. This was to give a fair-sized stretch of ground a uniform treatment in order to judge the effect of the formalin. To this larger breadth of treated leeks, the whole of the surrounding ground acted as a control. The water was brought up in a 400 gallon barrel.

The stronger solution used was 2½ ozs. of formalin to 1 gallon water. The weaker strength was 1¼ ozs. to 1 gallon One gallon was used at the rate of two rows, i.e. 60 yards. In this amount of solution we followed the recommendation of the American authorities, 1 gallon to 185 feet of row. This will result in a little over 200 gallons an acre with the drills 1 foot apart. This is a very large amount of water to cart, and it is possible that a stronger solution and a less amount of water might be used and experiments to this effect should be carried out The safety of the strength of the solution varies with the amount of water in the soil If there is plenty of moisture in the soil, which is usually the case in Scotland, the formalin is diluted in the soil and the danger of injury to germination is small If the soil be very dry a high percentage of formalin may result in lessened germination and injury to the stand

The disinfectant was poured in the furrows at a slow rate of walking and the field was immediately sown. The sowing was at the rate of about 18 lbs to the acre The furrows were filled in by foot, and the field was then rolled. The whole leek area was harrowed shortly after sowing and again later.

The rows were examined on May 5th. The weather had been very wet and cold and the seedlings were hardly through the soil. Once a week a gang of women went all over it weeding. This lessened the total number of plants a good deal, but the treatment was identical for the whole field By May 12th it was possible to start making a count. A frame of light wood one yard square, sufficiently rigid at the corners to remain true, was used in the count. From May 12th weekly counts were taken of the number of healthy plants and the number of smutted plants in various areas, taking sample square yards,—see Table.

In all some thirty or forty thousand plants were counted during May, June and July. The results are given in percentages. It was apparent from the first that in these conditions the formalin did no harm to the germination.

[TABLE I.

TABLE I.

Table of Results, showing percentage of Healthy Plants surviving at the dates shown.

	May 15.	May 22.	May 29.	June 5	June 12.	July 19.
Strong Solution ($2\frac{1}{2}$ ozs)	100	80	78	61	53	48
Weak Solution ($1\frac{1}{4}$ ozs)	100	85	67	39	34	33
Control	100	80	70	36	32	26

TABLE II.

Weight of Produce from 1 *square yard when harvested September* 23, 1925.

Average of samples from plot treated with formalin Strong Solution.	*Average of samples from Control. No treatment*
12 lbs. 5 ozs.	3 lbs. 2 ozs

The percentage table is based on the number of healthy plants surviving to the end of the experiment As can be seen in the figures of the best set, i e. those treated with the strong solution, a large number are always lost. This loss is expected and is due to the methods of weeding, harrowing, etc Seed is sown at a high rate to allow for considerable loss. A further large loss is sustained through the action of the disease when untreated.

There was a certain number of diseased plants, about 5 per cent, among the healthy plants to the very end, and these were counted separately It would take more than one season, and possibly a few years' treatment, before a thoroughly smutted field was healthy enough to produce no smutted plants in any given area, even if the area were small.

But the most striking feature was the difference in the average size of the plants from the treated plots and the untreated. This was emphasised when the test of weighing (see Table II.) was used. In the field the treated area both at Chancelot and at Inveresk could be seen at a good distance, and stood out from the very sparse plants and small specimens in the rest of the field.

Inveresk—On the 8th May a similar experiment with onions was started at Inveresk. The field was flat and in the open It had been sown in the beginning of April with onion seed and the strip for the experiment had been left unsown. The field was manured every two years with farmyard manure to the extent of 30 tons an acre, the land getting fish manure or guano on alternate years Seeding was at the rate of 25 lbs an acre.

The whole field was affected with Onion Smut, but the infection did not appear to be quite so heavy as that of the Edinburgh field. The experiment ground was a narrow strip across the field, running roughly north and south, 45 inches wide and 145 yards long. The drills were 9 inches apart. There were five drills in

the experimental strip. The same methods of treatment and measures of formalin were used as in the other experiment and the same strengths were applied, viz. 2½ ozs. per gallon and 1¼ ozs. per gallon. A barrel of water was stationed at each end of the strip.

The weather was dull and cold, and had been showery for a week or two before sowing. A very heavy shower fell immediately after covering in the drill. The four weeks following the formalin treatment were very wet and cold with little occasional sunshine. Unfortunately in this experiment the final count and weighing were not carried out, but the trend of the experiment was along the same lines, and the result so far as ascertained by 15th July was analogous to that of the experiment at Chancelot on leeks. The treated onions gave by 15th July 106 plants to the square yard, the untreated giving 63 plants to the square yard (on an average of many counts), and the same marked difference was noticeable in size and thriftiness. In this area the half strength, i.e. 1¼ ozs. to the gallon, gave fully as good results as the 2½ ozs.

Costs.—The formalin used in these experiments costs 13*s.* a gallon at the present time. Therefore if 2 ozs. a gallon were used, the cost of treating an acre would be about 30*s.* for the formalin, and the cost of the additional labour of a man or boy to water the furrow.

It is possible that the cost could be lowered in one or two ways:—

First.—Inquiries are on foot to find a cheaper formalin, but the answer is that if there were a large demand, a formalin would probably be produced that would answer the purpose and be cheaper than the high-grade article that is all that can be easily obtained at present.

Second.—Instead of the labour of a man, a contrivance is used in America whereby a can is fixed to the seeder, making one operation of sowing and disinfecting. A firm of agricultural implement makers could no doubt produce a simple machine of the sort suited to Scottish conditions.

Third.—The increased number of plants that mature with the formalin treatment would allow of some lessening in the very heavy sowing now practised, i.e. about 18 lbs. for leeks and about 25 lbs. for onions.

Conclusions.—It is manifest from the above two sets of experiments that while formalin does not in one season eliminate Smut from a field where the disease has obtained a strong hold, yet the timely application of a stream of formalin and water in the furrows does in a very large degree control the disease. There remains some disease, but the bulk of the plants are healthy and the total yield is more than doubled in weight.

Summary.—Onions and leeks in the Edinburgh districts are sometimes attacked by Onion Smut (*Urocystis cepulæ*), a short description of which is given. Experiments on the use of formalin as a solution, about 2 oz. to the gallon of water, applied in the furrow when sowing at such a rate that 1 gallon covers 60 yards of furrows, have been carried out from April to September 1925.

These experiments have shown that a practical control of the disease can be obtained in this way, although a small amount of disease may remain. The stand is largely increased, the total number of plants raised and the produce by weight is doubled.

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SOME RESULTS AND FURTHER POINTS IN THE FEEDING OF DAIRY COWS.

R. BOUTFLOUR, M Sc.

IN the JOURNAL for April 1925 the writer dealt generally with the system that he advocated for the management and feeding of cows. In this article it is proposed to give certain results and to deal more fully with some of the more important factors. The following are some of the results obtained :—

Herd N.K.W.—This herd was started in 1921 with ordinary commercial cows, mostly Friesians.

1921–2.	8,500 lbs.	average.
1922–3.	10,000 lbs.	„
1923–4.	11,600 lbs.	„
1924–5.	12,720 lbs.	„

The herd has been rationed since 1921. In the year 1922–3 they received a maintenance ration of hay, mangolds and silage. In the year 1923–4 they received hay and silage, but no roots In 1924–5 they received hay and concentrates for maintenance, but no roots and no silage.

They also had the following production ration :—

1	part	decorticated ground nut cake.
2½	„	rice meal.
1	„	linseed cake.
1	„	maize gluten feed.
2	„	palm kernel cake.

At the present time this herd, containing a total of 22 cows and heifers, three of which are dry, are averaging 43 lbs. of milk per head per day.

Herd A.H.H. Shorthorns.—This was a demonstration herd taken over last year never recorded; the milk sales, however, were under 700 gallons per cow. This year the herd officially recorded averaged 10,584 lbs., 9 averaging 13,000, 15 12,000 and 21 11,000 lbs.

This herd received a maintenance ration of hay and concentrates, but no roots. The production ration was the same as for Herd N.K.W.

Herd F.M.W. Shorthorns.—This herd has been rationed for two years, and last year were just short of 1,000 gallon average. This year, however, the average is 12,040 lbs. for the full time cows, and the individual yields vary from 8,117 to 20,826 lbs.

The maintenance ration consisted of hay and marrow stem kale, 30 lbs. The highest yielding cow gave 20,040 lbs. last year and between the two lactations of 20,000 she was only one week dry; in the two lactations she has calved inside the year and has never given more than 76 lbs. on any one day.

Herd H.L.L. Shorthorns.—This was a demonstration herd taken on last year. It had been previously officially recorded. The average yield in the years 1923-4 and 1924-5 were 6,986 and 10,232 lbs respectively. They received a maintenance ration of hay, concentrates and 15 lbs. roots.

The foregoing figures are enough to illustrate what can be done with ordinary commercial cows, and indicate that the present milk recording figures are not indicators of the potential output of cows, but rather that they are the indication only of the degree of management the cows are subjected to.

In the foregoing herds over 60 per cent. of the cows have yielded over 10,000 lbs, and those over the 10,000 have yielded an average over 12,000. These yields are obtained by systematic management and feeding with the aim in view of keeping the animals fit and in good condition, quite different from the condition of flabby fatness so often mistaken for fitness.

1. The management commences six weeks previous to calving with fitness as the aim in view. An account of the method was given in the previous article.

2. After calving, high yields are anticipated, and feeding is carried out slightly in excess of the yield (as compared with allowing feed to follow yield), and the results justify this method A large percentage of cows will only give high yields when well fed, and would never attain their maximum daily output if the feeding followed the yield. The increases have been obtained initially by preparation for calving, and the anticipation of high yields in the early part of the lactation period. When this object has been attained, the next point is to maintain this output for as long as possible during the lactation period; a large percentage actually attain their maximum some eight weeks after calving, keep up this production for some weeks, and then the yields fall gradually as the lactation period advances.

In the writer's opinion, a point which must be considered is the control of bulk of food fed per day as well as the quantity of food given at any one feed; further, this bulk may be of several types:—(1) total dry matter per day; (2) total bulk apart from dry matter.

The total dry matter per day and bulk of food must be sufficient to satisfy the animals' appetite and allow the digestive organs to work efficiently, but must not overtax the system. This point has possibly been overlooked by too many stock feeders in the past when dealing with heavy yielding cows or even potential heavy yielders. The feeders, being anxious to supply the animals with plenty of nourishment, have coaxed them to overgorge by

feeding liberally on pulped roots, hay and straw chaff mixed with meals, followed by hay *ad lib.* for all cows; the heavy producers received an extra feed of cake and meal in addition.

The writer is quite unable to agree with this method of feeding, because the stomach capacity of the cow does not increase in size in direct proportion to the milk yield. The stomach capacity is fairly constant, and the concentrated and bulk feed must not exceed 32 lbs. calculated as dry food for 11 cwt. cows if full efficiency is to be maintained, and for the average heifer of about 8-9 cwt. live weights 26 lbs. total dry matter appears ample.

Some heavy producers are fed a bulky maintenance ration which occupies about three-quarters of the stomach capacity, followed by cakes and meals, or still worse, liberal feeding of chaffed straw and roots; later the concentrates are thrown in to induce the cattle to clear up the food and lick out mangers; this again is followed by palatable hay, which induces the cow to further efforts in competition with her neighbours. The following examples will demonstrate this point:—

(1) 7 lbs. hay
14 lbs. oat straw } 24 lbs. total dry matter.
56 lbs. roots

This gives a maintenance ration for a cow of about 11 cwt. and is three-quarters of her full stomach capacity

Now attempt to feed this animal a comparatively concentrated production ration at 3½ lbs. per gallon of milk, and assume this is only 3 lbs. dry matter extra per gallon.

The following is the result:—

24 lbs dry matter maintenance.		
27 " " "	+1 gallon	Limit of 9 cwt. heifer.
30 " " "	+2 gallons.	
33 " " "	+3 "	Limit of 11 cwt. cow.
36 " " "	+4 "	
39 " " "	+5 "	
42 " " "	+6 "	

Can one expect high yields from this method of feeding?

	Dig. Prot	Starch Eq	Total Dry Matter.
(2.) 10 lbs. hay	0·4	3·2	8·5
10 lbs. straw	0 1	1·9	8 5
50 lbs. roots	0·3	3·75	6 0
1¼ lbs. decorticated ground nut cake	0·5	0·94	1·1
	1·3	9·79	24·1

This ration may be sufficient for maintenance and one gallon, but again when production rations are added the following results, with 3½ lbs. per gallon concentrates:—

24 lbs. maintenance	1 gallon.	
27 " "	2 gallons.	Limit of heifer's capacity.
30 " "	3 "	
33 " "	4 "	Limit of 11 cwt. cow's capacity.
36 " "	5 "	

Here also the ration needs alteration for heifers yielding over 2 gallons daily, and small cows over 3 gallons daily and 11 cwt. cows over 4 gallons daily.

	Dig. Prot.	*Starch Eq.*	*Total Dry Matter.*	
(3.) 20 lbs. hay	0 8	6·4	17	maintenance ration.

Using concentrates at 3½ lbs. per gallon—3 lbs. total dry matter approximately.

17 lbs. total dry matter.		
20 " " "	1 gallon.	
23 " " "	2 gallons.	
26 " " "	3 "	Limit of heifer's capacity.
29 " " "	4 "	
32 " " "	5 "	Limit of 11 cwt. cow's capacity.
35 " " "	6 "	

In this case one has a rather more satisfactory state of affairs, but again high yielders, both heifers and cows, need further concentration of their ration, and this is most simply effected by replacing 2½ lbs. hay by 1 lb. of production ration or using concentrates for maintenance:—

4 gallon heifer—

Maintenance	13 lbs hay ...	11½ lbs.
	2 lbs. concentrates	14 "
Production	14 lbs. concentrates	
		25½ lbs. total dry matter.

5 gallon heifer—

Maintenance	8 lbs. hay	26 lbs. total dry matter.
	4 lbs. concentrates	
Production	17½ lbs. concentrates	

Concentration of ration for heavy yielding cows of 11 cwts. live weight:—

5 gallon cow—

Maintenance	20 lbs. hay	17 lbs.
Production	17½ lbs. concentrates	15½ lbs.
		32½ lbs. total dry matter.

6 gallon cow—

Maintenance	13 lbs. hay ...	11 lbs.
	3 lbs. concentrates	21 lbs.
Production	21 lbs. concentrates	
		32 lbs. total dry matter.

7 gallon cow—

Maintenance	8 lbs. hay	33½ lbs. total dry matter.
	5 lbs. concentrates	
Production	24½ lbs. concentrates	

Here again one reaches the limit of maintenance concentration,

and further concentration of the production ration is necessary to reduce dry matter.

Supplementary ration for the last gallon from heifers and 1 to 2 gallons from cows producing heavily.

$1\frac{1}{2}$ lbs. raw linseed meal		
$\frac{1}{2}$ lb. meat meal	}	$2\frac{1}{4}$ lbs. per gallon.
1 lb. maize gluten feed		

It is quite obvious that if foods such as bran, $5\frac{1}{2}$ lbs. per gallon, sharps or brewers' dried grains, $4\frac{1}{2}$ lbs. per gallon, are fed for production, the dry matter capacity will be reached at considerably lower yields than those mentioned above; further concentrates for production must be laxative when fed in the quantities stated.

It is important to remember that it is necessary not only to keep down bulk per day, but also bulk per meal, and three times feeding of concentrates, each feed followed by one-third of the hay, is generally recommended, but in the case of high yielding cows, i.e. over 6 galls., it is necessary to increase the feeds to four per day.

The writer is of the opinion that foods containing a large percentage of water of vegetation if fed in excess retard digestion and are therefore not desirable

Milking—For high yields twice-a-day milking is inefficient, as it is difficult to keep animals at a steady yield and they seldom reach their maximum; whereas with three times milking, cows continue to rise longer after calving, reach a considerable higher maximum, and the rate of fall is reduced by more than 50 per cent

Very surprising results are obtained when three times milking is adopted, very often cows which do comparatively badly under twice milking have been some of the best cows in the dairy when three times milked

Summer Feeding.—For rationing cows in summer the following is recommended:—

Good grass will provide sufficient nutriment for maintenance and production of the first three gallons of milk. (*Note.*—If the daily yield exceeds five gallons, then assess the value of the grass at maintenance and the first gallon only.)

A ration of concentrates, similar to winter rations, should be fed for every gallon over three. As the season advances a tendency to fall off in yield will be experienced, the productive value of the grass must be reduced at once, till at the end of June the grass allowance has been reduced to two gallons and concentrates fed for all gallons over two.

From the end of July add to the grass to produce the first two gallons of milk 1 lb. of decorticated cotton or ground nut cake, increase this to 2 lbs. during August and 3 lbs. during September, continuing to feed a production ration for all gallons over two. In October feed for all gallons with a winter ration, as during this month it is important to get the cattle fit for the winter. On no account allow fresh calved cows to gorge themselves at this time of the year with a long bait of fall grass. Palm kernel cake, kibbled large and with the dust sifted out, is an excellent summer

food; it is a balanced ration, and should be fed at the rate of 3½ lbs. to the gallon of milk.

Summer Feeding Calendar.

MONTH.	Milk Yield				
	1 gall.	2 galls.	3 galls.	4 galls.	5 galls.
	Lbs.	Lbs	Lbs.	Lbs	Lbs
May and June.					
Balanced ration	...	...	...	3½	7
Early July.					
Balanced ration	...	...	3½	7	10½
Late July.					
Balanced ration	...	...	3½	7	10½
Decorticated cotton cake	..	1	1	1	1
August.					
Balanced ration	..	.	3½	7	10½
Decorticated cotton cake	...	2	2	2	2
September.					
Balanced ration	...	...	3½	7	10½
Decorticated cotton cake	...	3	3	3	3
October.					
Balanced ration ...	3½	7	10½	14	17½

Note.—Decorticated ground nut cake may be used instead of decorticated cotton cake

The housing of the cows during the heat of the day for three or four hours, and the feeding of the concentrates whilst indoors at this time, is strongly advocated. This prevents over-gorging with grass and allows a fuller digestion of the concentrated food given, the cows are also given a respite from the heat of the sun and are not worried by flies

There are plenty of potential 1,000 gallon cows in the country, and very large numbers of herds which can average 1,000 gallons or over. All that is required to discover these is a commonsense system of feeding as advocated above, blended with keenness and enthusiasm.

EXPERIMENTS CONDUCTED IN THE MATING OF QUEEN BEES.

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THE question of the relationship of the queen to the drones in her own hive has been the subject of experiments conducted over a period of three years with a view to the solution of the problem of pure mating, and the consequent possibility of more rapid improvement in the breeds of bees.

It has been an accepted fact by practically all writers of literature on bees that the queen bee is never mated with a drone from her own hive, but always with one from another colony. This statement is all the more remarkable as, so far as we know, no previous research work has been conducted to substantiate it.

It is well known to all beekeepers that mating takes place in mid air, and that only one drone is necessary, after which no further mating is required, the queen being capable, under normal conditions, of depositing eggs to populate the hive with her progeny to the end of her life. It is probable that this aspect of copulation has seized the imagination of writers and sustained the assumption that Nature has ordained this method to prevent inbreeding. We are told that only the swiftest and strongest drones can catch the queen during her mating flight, while other authorities have contended, without any proof, that at the mating season drones are in large numbers in mid air waiting for young queens to appear. Our experience does not agree with this latter statement Other writers contend that the drone is built chiefly for flying long distances, but our experience is that the drone rarely ventures very far away from his own domicile.

Our experimental work has been carried out chiefly with the aid of observation hives holding two to three standard combs, and of the character of those usually exhibited at Honey Exhibitions The glasses were so arranged that the movements of the bees could be observed at all times without difficulty. Six of these observation hives were in regular use throughout the year, and were exhibited at the Highland and Agricultural Show at Glasgow this summer. British, Dutch, Austrian, Italian and Golden Italian strains were used.

Each hive was stocked with worker bees, worker brood, drones, drone brood and fertile queen taken from normal colonies. After forming this nucleus of a colony a period of a week was allowed for the bees to settle down and get accustomed to their new home and surroundings. A little food was given. Exits were cut from the lecture room to permit of easy passage for the bees from their hive to the open air, and the inmates were allowed to work as a normal colony. The glass sides, which consisted of double thicknesses of glass, did not appear in any way to affect the work of the bees Queens were removed at intervals. Some of the hives were then given queen cells on the point of hatching, others allowed to rear their own queens, while in other cases virgin queens were introduced.

The following illustration is typical of the majority of our experiments.

The queen was removed from what we will call No. 1 Observation Hive, consisting of pure Dutch bees, and a ripe queen cell taken from another pure Dutch stock was introduced, allowing of course the usual 48 hours to elapse before introduction. The virgin queen duly hatched and was accepted by the colony. Curiously enough this event produced no unusual excitement in the hive; the inmates displayed little or no interest in an event which to us seems fraught with importance. The virgin queen at birth is wonderfully active and virile. Her food, we noticed, consisted of

honey taken by herself from the honey cells. We found in the majority of cases that usually two days from birth the virgin queen, if the weather was suitable, would leave the hive for a short flight, and again the following day, while in some cases we have observed three flights before the actual mating trip. The average period of these trips was from two to three minutes, and they were invariably taken towards the middle of the day. We have, however, occasionally seen these flights as late as four o'clock in the afternoon.

This action on the part of the virgin queen may be in the nature of a cleansing flight, or to develop the wing muscles, or possibly to familiarise herself with the surroundings, and enable her to mark her hive previous to the mating trip. The drones in the hive took no apparent interest in these proceedings, even when the virgin queen returned. In one instance we observed the workers very loath to allow the virgin queen to return to the hive, why we could not tell, but it is interesting to relate that a week later the virgin queen was missing. The workers during the virgin queen's absence exhibited no sign of queenlessness, and while she was in the hive no apparent interest was manifested in her. She seems to be constantly on the move walking from comb to comb.

To return to the case under notice. Six days from the birth of the queen we found the hive in a highly excited state. Two flights had already been made on the two previous days, but it was now evident that the actual mating flight was about to take place. The weather was fine and warm. At 12 o'clock we noticed the virgin queen hurrying towards the entrance. The drones in this colony were evidently aware of the virgin queen's intention. Some of them were already on the wing while others were on the alighting board. Attention was at once paid to the other observation hives to discover if any excitement prevailed in them, or if in any way some system of intercommunication bearing on this event existed among them. In the remaining five observation hives headed with virgin queens, and with workers and drones, normal conditions prevailed with not a drone flying, although the whole were in the same room and separated by a few feet only. With the assistance of the students and members of staff a watch was kept at the entrances of the colonies in the apiary. This apiary consists of fifty full stocks of bees in W.B.C. hives, and the bees were at the time busy with the storing of honey. These colonies are situated immediately in front of the observation hives, the front row in fact being only three or four yards away. Not a drone could be observed either flying or in front of the hive entrances during the period that the virgin queen from the observation hive was on her mating trip. In all the established colonies nothing but normal conditions were observed. Our observations both in this and many other cases we tried convinced us that the mating of the virgin queen from one hive has no bearing on another, and we can dismiss the theory of any scent connection entirely. The virgin queen returned in three minutes exactly with the drone appendage attached to her abdomen. Two days following her mating trip she deposited her first eggs.

Later on we were able to tell from her progeny that she had been mated with a drone from her own hive, a conclusion confirmed the following year when the hive exhibited the general characteristics of this race of bee

Similar experiments were carried out with British, Austrian, Italian and Golden Italians, and identical results obtained. There were slight variations in the times of mating and the numbers of flights before mating, but these variations were evidently due usually to different climatic conditions.

Practical Mating.—With this knowledge we then decided upon a further practical trial to test the possibility of mating queens with drones from a special colony at a cost within the reach of the average beekeeper.

For some considerable time the Beekeeping Department of the West of Scotland College of Agriculture has been conducting experiments with the various races of bees, more particularly with a view to discovering the most valuable strain of bee suitable for the South and West of Scotland, and for this purpose many colonies of the native race have been purchased from all parts of Scotland. It was the endeavour to obtain pure mating for this scheme that led us to conduct the experiments contained in this report

For the purpose of this experiment 25 Swiss mating boxes were used. Into each box a pint of Dutch worker bees was placed The plan adopted to obtain these bees was to "drive" a skep of Dutch bees over a queen excluder, thus preventing queen and drones passing through. The driven bees were then syringed with cold water. This prevented them from flying and facilitated our work in spooning them out in a mass and filling the mating boxes. Food in the form of sugar syrup was given and the bees securely fastened in with adequate ventilation. These boxes of bees were then placed in a cool dark shed for the night. By morning the bees were perfectly dry, having generated heat during confinement Previous to this experiment a native colony, purchased some months previously from West Argyllshire, was rearing queens on the cell cup principle, while another native stock procured from Arisaig was being used for mass production of drones, achieved by the liberal use of drone comb.

As all beekeepers are aware it is very difficult to make old bees stay in a new location, particularly when their old home is only a few yards away. It was therefore necessary to remove the small mating boxes some distance from the apiary. An old quarry some two and a half miles away was used and the bees transported. On arrival the entrances were opened, more food given, and at the same time a ripe queen cell was introduced from the queen rearing colony.

The drone rearing colony was removed at the same time to the mating station. A liberal shaking of the combs in front of the mating boxes gave each a number of healthy strong males. This process was repeated the second day. The weather was not at all ideal. for mating, but notwithstanding this fact we discovered within a fortnight after the introduction of the ripe queen cells 21 of the queens were mated and four missing. Later in

the year we were able from the progeny of the queens to prove that all had been pure mated, although within 400 yards of the station there was a beekeeper with six colonies of bees comprising Italian and Austrian strains.

We then decided to carry out further tests in the College apiaries to discover the reason for the beekeepers' contention that queens often mated with alien drones. In a very limited space we have at present 150 colonies of bees of various strains, including British, French, Austrian, Dutch, Italian and Golden Italians.

We decided to rear a number of queens and mate them in the home apiaries, where the queens would have every chance of mating with alien drones. The observation hives were stocked with pure races of bees and queens, but later the queens were removed and ripe queen cells given In the observation hive containing the British race we observed Italian drones had gained admittance and had been accepted as permanent residents in the hive. We also noticed in other observation hives a casual stranger. This led us to make a close inspection of those nuclei with virgin queens, and where alien drones were noticed a record was made. Examination later in the season, when the young queens were laying, revealed that in 5 per cent. of the nuclei the progeny were related to the alien drones, while in the remaining hives pure mating had been accomplished.

By observations in the late autumn on colonies of bees in possession of virgin queens we had further proof of this feature of mating. Such colonies continued to give sanctuary to their own drones, and we also found that a queenless colony would actually keep drones all through the winter, evidently in response to the instinct to preserve them for the mating of the needed queen. In colonies with mated queens only a few feet away all drones were destroyed; if mating usually takes place with drones from another colony we should expect colonies with mated queens to keep drones for this purpose.

Conclusion—Our experiments tend to show that provided no other drones are admitted to a colony of bees the virgin queen will mate with her own drones, and it is therefore possible to bring about pure mating or the crossing of queens with any other variety of the same type.

I desire to place on record my appreciation of the assistance I have received from my two colleagues, Mr. William Hamilton and Mr. James Struthers, without whose help it would have been impossible to conduct the experiment.

Paris Green and Grub.

DURING last spring grub was very prevalent on many farms in the North of Scotland. In some cases whole fields of oats after lea were entirely destroyed, and there were very few fields that were not more or less damaged. The pest was found to attack not only lea oats, but also other kinds of farm and garden crop.

Special interest, therefore, attaches at the present time to

certain trials that have been carried out in the North with a new method of combating this very destructive pest. Hitherto, the remedial measures used by farmers have consisted of certain cultural methods—chiefly heavy rolling immediately after harrowing—and the use of good seed and stimulating manures to combat the pest, but even under the very best circumstances these, as a rule, are only partially successful. Their object, it may be pointed out, is not directly to kill the grub but to confine its movements in the soil, or to produce a strong, healthy, vigorous plant that will be better able to outlive the attack.

The new method referred to, however, is designed directly to kill the grub itself, and, so far as the trials in the North have gone, the method appears to be very successful. It consists in the application of Paris Green, a very poisonous compound of copper.

The use of Paris Green as a method of combating the grub has long been used in the U.S.A., and since 1921 it has been under trial in the south-west of Scotland. So far as we are aware, however, it has never been used in the north of Scotland until the present season.

The Paris Green is mixed with bran and water in the following proportions: 30 to 40 lb. bran, 1 lb. Paris Green and 2 gallons water, these quantities being sufficient for 1 acre. The material is applied on the surface and is not harrowed in. This application should be made after the oats have brairded and before there are any signs of the grub attacking the crop.

As Lead Arsenate has been used for several years at Craibstone as an insecticide in the garden, it was thought that it would perhaps serve the same purpose as the Paris Green. This material, used in the same proportions as the Paris Green, was applied to an acre of lea oats where grub were seen in very large numbers. The material, however, had no effect whatsoever on the crop, a close examination of the whole field failing to discover a single dead grub.

Several former students of the Agricultural College carried out trials with the Paris Green, and in almost every case they found it to be very effective. One of the experimenters reported that he treated 3 acres of a field of lea oats on the 7th of May, and left 3 acres alongside untreated. At the time the materials were applied the grub had just begun to attack the crop. Within five days he noticed a very marked difference between the treated area and the untreated, and then on the 14th May he applied the material to the 3 acres untreated on the 7th May, with the exception of a small square which he left in the centre. The second 3 acres had been by this time slightly thinned out, but they improved enormously within three days after the application had been made, and by the 1st of June gave every evidence of turning out a good crop. The small square, however, that had not received any application at all, was by this time almost entirely bare, only a plant here and there being seen. So marked was the effect of the treatment that, during the summer, any little spot that had been missed in the sowing stood out very distinctly. He had no difficulty in gathering any number of dead grub within two or three days after the application of the Paris Green was made.

Fears have been expressed by some that the application of this deadly poison on the surface of the soil might be deadly to poultry, either by the poultry eating poisoned bran or by eating dead grub. Enquiry on this point was made of all the experimenters, and several of them reported that, although their poultry were going regularly every day to the treated fields, there was no sign of their coming to any harm.

In one case, where a field had been planted out with strawberries the previous year, considerable damage was done to them by grub. During the third week of May an application of Paris Green was made in the same way as to oats, and the treatment was equally effective, many dead grubs having been found.

The Marketing of Eggs.

THE following article is the substance of an address delivered at a meeting of Poultry Instructresses at Aberdeen, in October 1925, by Mr. D. S. Carmichael, of Thos. Howden, Ltd.

Before the position of Scotland in the distribution side of the egg industry is considered, it is interesting to look at the methods adopted by other countries to meet their particular requirements

Denmark, which is mainly dependent for its existence on its exports of butter, eggs and bacon, has an excellent system of marketing its eggs. Its products command the highest prices on the British market, and the public know that a ticket in the shop with "Danish Eggs," "Danish Bacon," or "Danish Butter" on it stands for quality. Denmark has reached this standard because the Government educates the peasant farmers to take an intelligent interest and pride in their produce, and from time to time introduces legislation to assist the industries mentioned. I have been told that in the small villages the minister and schoolmaster assist the Government by impressing upon these peasant farmers the need for producing nothing but the best, as Britain is their best customer, and the export of inferior goods to Britain would result in the loss of their livelihood.

The position that Denmark holds to-day in the market for eggs is to my mind attributable to the fact that the eggs are bought from the farmer by weight at so many ores per pound, not as in this country at so much per dozen. The Danish system naturally rewards the individual who supplies the largest eggs, and this has practically eliminated the small egg, except at certain seasons of the year. Over 20 years ago Danish eggs weighed about 14½ to 15 lbs. per 10 dozen, to-day mostly 15½ to 17 lbs. or even 18 lbs. are the weights of the eggs exported.

On the 1st of August this year a Bill was introduced in the Danish Parliament dealing with the export of eggs. The principal points in the Bill were that all eggs must be shipped weekly and must be graded and weighed to standard weights, viz. 13 lbs., 14 lbs., 15½ lbs., which is the best commercial size, and 17 lbs. and 18 lbs. per 10 dozen. Eggs must weigh these weights which are stamped on the cases. They are classified into two grades of quality—1st and 2nd assortment. All exporters must receive a

license from the Government and keep authorised books regarding all their exports. For infringement of the conditions of export the license-holder can be fined 20 kroners to 2,000 kroners, and in cases of repetition the license can be cancelled.

This Bill is doubtless the result of representations made by importers in this country to the Danish Government last year regarding the quality of eggs then being exported. The principal shippers in Denmark were holding up the eggs for speculation till the quality had deteriorated very greatly. This new Bill has stopped this speculation and we are now getting eggs from Denmark of perfect quality, which will naturally increase the demand for Danish eggs.

That the Danish Government are drastically carrying out their new regulations is demonstrated by the following incident:—One of our shippers wrote us that on one occasion when the Government Inspector called at his premises he had some eggs about a week old, and because they had not been shipped, he made him classify all his eggs sent that week as "second assortment."

Ireland has also improved her marketing conditions. The North of Ireland has made rapid strides within these last two years by drastic legislation, and is now shipping eggs to this country of practically perfect quality.

Eggs must be packed in cases recommended by the Government; they must be graded and sold by weight; no dirty eggs to be packed; no duck eggs mixed with hens' eggs; cold storage eggs must be branded "cold storage" and pickled eggs branded "pickled eggs" on the cases; all exporters must have a license to export and their premises must also be licensed as suitable.

After 1st May each year all eggs must be tested by the single light test Any farmer offering for sale bad eggs in any of the markets is subject to a fine of £20 per bad egg. The first prosecution under the Act concerned a farmer who offered 33 eggs in the market unfit for human food. He was fined £4, although it was pointed out to him that he could have been fined £660.

This legislation has had the desired effect upon the farmers and now bad eggs are almost unknown. If importers should receive any such, the circumstances have only to be reported to the Ministry of Agriculture and on a repetition of the offence the shipper would lose his license.

I was asked to judge the packing and grading of eggs by the North of Ireland Government these last two years at Belfast and marks were given for the following points:—

External appearance of case	5
Finish of package with regard to safety in transit	5
Attractiveness and style in packing	10
Compactness	5
Freedom from breakages	15
Freshness	20
Cleanliness	20
Uniformity of size	20
	100

This last year the winner received 99¾ marks, the second having 99, the third 98¾ and the fourth 97, while six competitors were equal with 96½. These marks shewed the high standard that had been reached in the short space of two years, the whole export being revolutionised.

In Ulster in June 1924 there were altogether 7,000,000 head of poultry or 276 per 100 acres of cultivated land, compared with 133 per 100 acres in England and Wales and 90 in Scotland. The exports from Northern Ireland amounted in value to £2,183,635 in 1924, and from 1st January to 1st July 1925 they amounted to £1,936,690, so that the value of exports in 1925 will be considerably more than that of 1924.

The three points they are concentrating on are freshness, cleanliness and size. They regret now that buying by weight was a provision not included in their last Bill. This, however, is bound to come, as it is the only way to reward the careful producer. Merchants are asking for this measure.

Free State Ireland also introduced legislation on the 1st August 1925 dealing with the marketing of eggs, and there has been a marked improvement since in their eggs.

Canada and America have also legislation dealing with their egg trade both for home consumption and export. Their eggs are graded into four classes: specials, extras, firsts and seconds. It is of interest to know that the value of the egg and poultry crop of America two years ago was worth one and a half times their wheat crop. The consumption of eggs in Canada and the United States is about 207 per head, whereas the consumption of eggs in Britain in 1913 was 120 per head and in 1920 it fell to 93 per head. I have no record of what it is to-day. If we could increase our consumption of eggs in this country to 150 per head we would require 5682 millions of eggs, which would require about 18,000,000 more hens in Britain.

Nearly all exporting countries grade their eggs in different manners, and at the present moment there are 24 different countries exporting eggs to this country. In 1924 the total value of eggs imported into this country was £15,504,314, Denmark being the chief importer with a total of £5,495,772.

The countries who have made most progress are those whose governments have introduced legislation to improve the marketing of their egg production.

In Scotland the problem of improving methods of distribution is a difficult one. At present nearly all eggs are collected from the producer through merchants, who in many cases give goods in exchange for eggs and who are not interested in the improvement of the standard of the eggs. Under this system the careless producer gets the same price as the careful producer, who is proud of his or her produce; consequently there is no incentive to go on improving their eggs. The careless hen-wife may be a far better customer than the other, and the merchant gives her an equal price in order to get her custom. A few producers are more fortunate than others in being near large towns, where they get a few cases sold at special prices to private houses, hotels, etc., but this trade is a limited one, as the big consumers of eggs are the

working class and middle class people, many of whom would never see an egg if it were not for the large imports of the cheaper class of eggs from countries such as Poland and Russia.

Good results might be obtained from the holding of competitions at agricultural shows. In such competitions the points to concentrate on are size, freshness and cleanliness. Legislation, however, is required, and in it the following matters should be dealt with:—

1. Buying eggs by weight.
2. No dirty eggs to be offered for sale.
3. Fine for offering bad eggs for sale; this should apply to producer, collector, egg merchant and grocer.
4. Cases to be standardised.
5. Cold storage eggs and pickled eggs to be marked as such. Heavy penalty for mixing cold stores with new laids.
6. Home eggs all to be stamped. Stamps to be sold to producers by Board of Agriculture.
7. All producers, collectors and egg merchants to be licensed.
8. Railway Companies to give special attention to handling of eggs; special rates at Company's risk.

A Committee might be got together from different parts of the country consisting of producers, collectors, wholesale merchants and grocers to consider the necessary legislation to be adopted which would at the same time protect both the producer and the consumer and would apply to all sections of the trade.

Notes from Craibstone.

Earliness of Ripening in Oats.—Over a considerable part of the area served by the North of Scotland College of Agriculture, earliness of ripening of the oat crop is possibly of much greater value than any other property, and, therefore, during the past few years in connection with oat experiments, particular attention has been directed to the many factors on which this earliness of ripening depends It is well known of course that there are great differences between different varieties as regards the length of period of growth and the date of ripening, even where they are all sown at the same time and under the same conditions as regards soil and manuring. It has generally been found that the following varieties are markedly early, viz.:—Orion, President, Dala, Garton's Early, Superb, Captain a d Yielder. The first two are black oats and the others white. The ordinary strains of Potato and Sandy are generally considerably later than those mentioned, but there has lately been under trial here two strains of Potato—Tersets and Utility—and a New Sandy brought out by Mr. Runciman of Castleton, all of which have been from seven to ten days earlier than the ordinary strains

But earliness is not entirely a fixed property of any single variety. The date of ripening of any single variety may vary very much with the conditions of the soil, season, etc. For example, it has been noted that in early seasons there is not so much difference between the date of ripening of varieties that are

generally considered to differ very much in this respect. On the other hand, in late seasons there has always been found to be a much greater difference between them. Also, in an early season the grain ripens more uniformly than in a late season.

The time of sowing has also a very considerable effect on the date of ripening. It may be taken generally that early sowing means early ripening, but varieties differ very much from each other in this respect. For example, it has been noted here that while early sown Potato oats ripen about a week or ten days earlier than early sown Victory, the Potato oats on the other hand, when sown late, are usually quite as late or even later than Victory sown at the same time. It this connection it has also been noted that when early sown the grain ripens uniformly, whereas late sown contains a considerable number of "greens," which reduces the quality and also the bushel weight.

There is often a drawback, however, in sowing early after lea in that the crop is liable to be attacked by grub. Nowadays, however, the use of 1 lb. of Paris Green, about 30 lbs. Bran and 2 gallons of water per acre, just when the plants are brairding, or soon after, has been found to be an effective preventive.

Thickness of seeding also has been found to have a marked effect upon the date of ripening, the thick sowing having been earlier than the thin sowing. A diminution of 25 per cent. in the seed has been found to lead to the crops ripening about a week later, the difference being more marked in a late than in an early season.

As regards manuring, the no manure plots have always been considerably later than those receiving artificial manures. Where Nitrate of Soda and Sulphate of Ammonia or other nitrogenous manures have been included the crop is usually considerably earlier than the no nitrogen plot, provided always that these materials have not been used in excess. The best results as regards earliness have invariably been got where a complete manure has been applied, and in this connection Superphosphate has always been found considerably superior to any other form of phosphatic manure. No doubt the effect of the manure is in giving the plant an early start, and this with any particular variety has a markedly beneficial effect upon the earliness of ripening. This must not be taken, however, to mean that an early brairding variety necessarily ripens early Indeed, there have been some very marked exceptions to this rule. For example, Yielder has been found to be one of the slowest of all varieties under test to braird and yet it is one of the earliest ripening varieties Marked differences have always been noted amongst different varieties as to the length of period necessary for ripening after the plants have come into ear. The following Table gives rather interesting results with 5 varieties in this respect.

	In Ear.	*Ripe.*
Sandy	24th July.	2nd September.
Victory	20th „	9th „
Potato	26th „	2nd „
Crown	22nd „	9th „
Superb	18th „	26th August.

It will be noted here that in the case of Sandy there was a period of 41 days between coming into ear and ripening, whereas in the case of Victory there was an interval of 52 days. A variety, therefore, that comes into ear comparatively early may not necessarily be an early ripening variety.

As a result of these observations it has been concluded that, apart from the selection of a variety, which is a very important point, early sowing, liberal manuring with a complete manure, and thick seeding will generally have a marked beneficial effect on the earliness of the crop.

Rat Destruction: The Use of Calcium Cyanide.

CALCIUM cyanide as a commercial proposition has recently been placed on the market in Britain. The material is manufactured at Niagara Falls by the American Cyanamid Company of New York. It is largely used in America for fumigating greenhouses, bushes and trees and for destroying vermin such as gophers, prairie dogs and wood-chucks. The toxic agent is hydrocyanic acid gas, which is given off by the cyanide when in contact with moisture in the air or in the ground. On no account should it be used in any inhabited building or enclosed space, and in greenhouses it must be handled with the utmost precaution and only by an expert.

Experiments have been made to discover the best method of applying cyanide and to test its efficacy for the destruction of rats. One tablespoonful in flake form placed well inside each burrow, the entrance to which has then been closed, has proved very effective. Twenty-four hours later few of the holes had been opened from the inside, and those few had probably been opened by rats which were in a part of the burrow to which the gas had not penetrated.

By closing lightly in the evening all the rat holes in a burrow and next morning placing cyanide only in those holes which have been opened, a considerable saving in the expenditure of the material can be effected. A tin containing 5 lbs. is sufficient to kill all the vermin in a burrow with approximately 50 openings, provided that the unused holes and bolt holes have been closed previously.

Calcium cyanide in the form of dust can be blown through a burrow by a suitable machine which costs 35s. This method has not been thoroughly tested yet, but it is effective.

There is one unexpected result of the effect of this gas on rats compared with the effect produced by sulphur dioxide or chlorine. Rats which escape from the burrows after being gassed with either of the latter gases almost invariably die of congestion of the lungs, but, though hydrocyanic acid gas is far more deadly than sulphur dioxide or chlorine, those rats affected by it which rush out of the holes and lie in the open, apparently moribund, recover completely in a short time

It is therefore advisable to force an ample amount of cyanide through the burrow and also to prevent rats escaping into the open. This latter end should not be achieved by the simple process of closing all the exits, as this prevents the gas from circulating freely, and probably pockets are formed, where there is no

lethal gas at all, and where several rats may remain unaffected. The opening should either be netted or have tins, with the lid removed and a hole punched in the base, placed in them. If sufficient assistance is available it is unnecessary to net or place tins in the openings, but dogs must not be allowed to sniff at any hole in case they receive a fatal dose of the gas.

Calcium cyanide can be obtained in 5 lbs. and 25 lbs. hermetically sealed tins To local authorities the cost is 2*s.* and 1*s.* 7*d.* per pound respectively. The public can obtain the material at a slightly higher cost only through a chemist.

A tin containing 5 lbs. is the most convenient to use.

International Year Book of Agricultural Statistics, 1924-25.

THIS Year Book, which is published by the International Institute of Agriculture, gives a most comprehensive survey of world agriculture, together with statistics of international trade in agricultural produce. The volume contains a series of tables relating to the area and population of 219 different countries and territories, followed by statistics of production and yield, the numbers of live stock, the supplies and prices of fertilisers, the prices of various agricultural products, ocean rates of freight and exchange rates. Section II. of this edition, which deals with the apportionment of areas, agricultural production and numbers of live stock in various countries, is more detailed than in previous years, and has been considerably enlarged. The Year Book may be purchased from the Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S W 1, price 8*s.*

Guide to Current Official Statistics, Volume III.

THIS publication has now established itself as an indispensable guide to the matters with which it deals, as is shown by the large sales of Volumes I. and II, which were noticed in the JOURNAL at the time of their appearance (see the issues of January 1924 and January 1925). The new volume includes publications of the year 1924, with notes of the issue of corresponding volumes in 1925, and also includes a selection of other important publications that appeared in 1925 up to the date when the *Guide* went to press. The plan is the same as that of Volume II, in which certain improvements were made on Volume I. The first section consists of a subject index of 172 pages, with numerous cross-references, while the second section of 57 pages contains a list of publications, each with a serial number, which is used throughout the first section as a reference. A new feature is the inclusion of the publications of the Government Departments of Northern Ireland. The Appendix to Volume II., giving a list of the more important statistical publications issued between 1900 and 1922, is not reproduced, but it is considered that a similar Appendix brought up to date may usefully be incorporated from time to time with future issues. Copies of the new volume may be obtained from H.M Stationery Office, 120 George Street, Edinburgh, either directly or through any bookseller, price 1*s.* net, or by post 1*s.* 3½*d.*

Annual Estimates of the Produce of Crops.

THE following statement regarding the produce of crops for 1925 was issued on 30th November:—

Preliminary Statement showing the ESTIMATED TOTAL PRODUCE and YIELD PER ACRE of Wheat, Barley, Oats, Beans, Hay, Potatoes and Roots in SCOTLAND in the Year 1925, with COMPARISONS for 1924, and the AVERAGE YIELD PER ACRE of the Ten Years 1915-1924.

CROPS.	Estimated Total Produce		Acreage.		Average Estimated Yield per Acre.		Average of the Ten Years 1915-1924.
	1925.	1924.	1925.	1924	1925.	1924.	
Wheat	*Tons.* 54,000 *Quarters.* 246,000	*Tons.* 49,000 *Quarters.* 231,000	*Acres.* 48,617	*Acres.* 49,449	*Cwt.* 22·3 *Bushels* 40·5	*Cwt.* 19·8 *Bushels* 37·3	*Cwt.* 21·1 *Bushels.* 38·7
Barley (including Bere)	*Tons.* 136,000 *Quarters* 730,000	*Tons.* 129,000 *Quarters.* 683,000	152,901*	151,588	*Cwt.* 17 8 *Bushels* 38 2	*Cwt.* 17 1 *Bushels* 36·0	*Cwt.* 16·9 *Bushels.* 35 1
Oats	*Tons.* 716,000 *Quarters.* 4,812,000	*Tons* 701,000 *Quarters.* 4,858 000	925,995	955,535	*Cwt* 15 5 *Bushels.* 41·6	*Cwt.* 14·7 *Bushels.* 40 7	*Cwt.* 14·3 *Bushels.* 39 3
Beans	*Tons.* 3,000 *Quarters* 13,400	*Tons.* 3,500 *Quarters.* 15,600	3,409	3,732	*Cwt.* 17·6 *Bushels.* 31 5	*Cwt.* 18·7 *Bushels* 33·5	*Cwt.* 19 1 *Bushels.* 35 5
Hay from Rotation Grass	*Tons* 646,000	*Tons.* 720,000	403,097	415,322	*Cwt.* 32 1	*Cwt.* 34·7	*Cwt.* 31·1
Hay from Permanent Grass	148,000	152,000	109,015	109,703	27·1	27 7	25·7
Hay from Timothy Meadows	97,000	102,000	47,229	45,062	41 0	45 3	42·0
Potatoes	995,000	845,000	142,155	138,281	*Tons.* 7·0	*Tons* 6·1	*Tons.* 6·5
Turnips and Swedes	6,815,000	6,752,000	395,940	405,693	17·2	16·6	16·7
Mangolds	20,900	22,700	1,117	1,316	18·7	17·2	18·5

* Excluding 20 acres, the produce of which was cut grass.

The winter sowings of wheat were carried out satisfactorily, but at the time of the spring sowings the ground was unusually wet

and cold. The crop suffered no serious check during the early stages of growth, and the warm, dry and sunny weather in June and July caused rapid development. Harvest began earlier than usual under exceptionally good conditions and was practically completed by the end of September. As a result of the favourable summer, the grain matured well and the straw was strong and clean. Smut was reported in one area, but speaking generally the crop suffered little damage from disease or insect pests. The sowing of barley was delayed by the wet weather. Germination was rather slow and irregular, and in a few districts it was necessary to resow fields owing to damage by grub. Warm dry weather in June and July, however, greatly improved the condition of the crop and growth was vigorous until checked by drought. Harvesting began early but was somewhat protracted owing to showery weather. The grain generally is of good quality and the yield is slightly above the average, but straw is shorter than usual. The oat crop was considerably affected by the wet cold weather of the spring months, and in May the prospects gave rise to some anxiety. Grub was unusually prevalent and resowing became necessary on a rather large scale. The dry warm summer, however, much improved the crop, and the plants generally developed satisfactorily. Harvest was delayed by showery weather in August and September, and some damage was caused by lodging and second growth, but in most areas the crop was ultimately secured in good condition. The yield varies considerably in different parts of the country but, taking Scotland as a whole, it will be seen that the produce is above the average. The grain is generally of good quality but, as in the case of barley, straw is short.

The planting of potatoes was carried out later than usual in many cases and development was at first checked by low temperatures. With the favourable summer conditions, however, the crop became vigorous and healthy and, owing to the absence of frost, growth continued into October. The crop was unusually free from disease and the yield has proved to be above the average. The prospects for turnips were not encouraging during the earlier stages of growth; the plants were slow in brairding and suffered from drought during the summer months. During the autumn, however, as a result of the mild and moist weather, growth was rapid and in most districts the yield is satisfactory. In the north-eastern and eastern districts "finger-and toe" has been prevalent to a small extent, but elsewhere the crop is practically free from disease. The yield of mangolds is slightly above the decennial average and the crop is of good quality.

The total produce of wheat, 54,000 tons, exceeds that of last year by 5,000 tons, or 10·2 per cent. The area under the crop is less than last year by 832 acres and is the smallest recorded since 1908; on the other hand the average yield per acre, 22·3 cwt., is greater than in 1924 by 2·5 cwt. and exceeds the decennial average by 1·2 cwt. Barley, with a total produce estimated at 136,000 tons, shows an increase of 7,000 tons or 5·4 per cent. on the previous year's total. As compared with 1924 the area harvested has increased by 1,313 acres; the average yield per acre by weight, 17·8 cwt., is greater by 0·7 cwt. and exceeds the ten years' average

by 0·9 cwt., while the average yield by measure, 38·2 bushels, is 3·1 bushels in excess of the decennial average and is the highest recorded since 1898. The total production of oats is shown as 716,000 tons, an increase, as compared with the previous year, of 15,000 tons or 2·1 per cent.; the area under the crop has diminished by 29,540 acres, and with the exception of the year 1914 is the lowest on record. The yield per acre, 15·5 cwt., exceeds that of last year by 0·8 cwt. and is 1·2 cwt. greater than the ten years' average. The produce of beans, 3,000 tons, is 500 tons less than last year's total, while the area under the crop, 3,409 acres, shows a diminution of 323 acres. The yield per acre, 17·6 cwt., is less than in 1924 by 1·1 cwt. and falls short of the decennial average by 1 5 cwt. Both total produce and acreage under the crop are the lowest on record.

The total produce of hay, taking all kinds together, is 891,000 tons, being 83,000 tons, or 8·5 per cent, below the previous year's tonnage. Hay from rotation grass shows a total produce of 646,000 tons, a decrease of 74,000 tons, or 10·3 per cent. The yield per acre, 32·1 cwt., is less than in 1924 by 2·6 cwt. but is greater by 1·0 cwt. than the decennial average. The total produce of other hay, which amounts to 245,000 tons or 9,000 tons less than last year, comprises 148 000 tons from ordinary meadows and 97,000 tons from Timothy meadows. The former has a yield of 27·1 cwt. per acre or 0·6 cwt. less than in 1924, but 1·4 cwt. greater than the decennial average, while the yield per acre of Timothy meadows, 41·0 cwt., is 4·3 cwt. less than in 1924 and is 1·0 cwt below the decennial average. The average yield of the two together, which is not shown in the table, is 31·3 cwt. or 0·8 cwt. in excess of the ten years' average.

The total produce of potatoes, amounting to 995,000 tons, shows an increase of 150,000 tons or 17·8 per cent. over that of last year; the area under the crop, 142,155 acres, is 3,874 acres greater than last year, while the yield per acre, 7·0 tons, exceeds last year's yield by 0·9 ton and the decennial average by 0·5 ton. The produce of turnips and swedes has increased by 63,000 tons or 0·9 per cent. to 6,815,000 tons, but the area, 395,940 acres, is 9,753 acres less than last year and is the lowest on record. The yield per acre, 17·2 tons, is 0 6 ton higher than last year and 0·5 ton more than the decennial average Mangolds show a total produce of 20,900 tons, or 1,800 tons less than the small crop of last year. The total produce and the area under the crop are the lowest recorded since the years 1895 and 1894 respectively; the yield per acre, 18·7 tons, is greater than for the previous year by 1·5 ton and exceeds the decennial average by 0·2 ton.

It will be observed that every crop except beans and hay from timothy meadows shows an increased yield per acre as compared with the ten years' average in each case.

Acreage under each Variety of Potatoes in 1925.

A STATEMENT is printed at page 114 showing the acreages under certain varieties of potatoes in Scotland in 1925, as returned by growers of one acre and over. These returns cover 124,178 acres out of the total acreage of 142,155, the difference being accounted for by the complete exclusion of certain districts in the Highlands and Western Islands, and by the exclusion of holdings on which less than one acre is grown.

The area under First Earlies, 15,955 acres, shows a small increase of 216 acres as compared with 1924. Epicure has increased by 489 acres and covers 59 per cent. of the total acreage. Sharpe's Express, with 2,131 acres, again comes second, and Eclipse third, each of these showing a moderate increase, while Duke of York is still fourth, but shows a decrease of 305 acres or 18 per cent. The other varieties among them cover only 7·5 per cent of the total acreage.

Second Earlies also show a small increase, the area being 17,692 acres as compared with 17,584 in 1924. Great Scot, with 9,167 acres, again covers more than half the total acreage, and British Queen, with 5,774 acres, covers nearly one third. The Ally comes third with 754 acres, while Arran Comrade has fallen to the fourth place with a decrease of 287 acres.

Maincrops, with a total acreage of 90,531, show an increase of 3,710 acres, and account for almost all the increase in the whole area returned. The outstanding feature is the increase in the area under Kerr's Pink from 17,574 acres to 30,623 acres, which raises it from third place to an easy first. Arran Chief comes second with 16,175 acres, showing a decrease of 2,763 acres; King Edward VII. is third with 15,434 acres, a decrease of 3,270 acres; and Golden Wonder fourth with 10,560 acres, a decrease of 2,660 acres These four varieties account for 80 per cent. of the total acreage Of the other varieties with more than 500 acres, Majestic and Field-Marshal show substantial increases. while Sutton's Abundance, Champion, Crusader, Langworthy, Tinwald Perfection and Up-to-date show considerable decreases, and Arran Victory and Rhoderick Dhu show little change.

The total area under immune varieties is 64,184 acres and that under non-immunes 58,796 acres, while unspecified varieties cover 1,198 acres. The respective percentages are 51·7, 47·3 and 1·0 Last year the corresponding percentages were 45·9, 53·3 and 0·8. Thus for the first time immune varieties cover more than half the total area returned. Reference is made to the JOURNAL of January 1925, page 84, where an account was given of the changes in the acreage of varieties that took place between 1918 and 1924.

Agricultural Returns for Scotland, 1925.

THE Abstract of the Agricultural Returns, printed on pp. 115-122, shows that the total area under crops and grass amounts to 4,705,197 acres, a decrease of 10,093 acres as compared with 1924, the arable land having decreased by 43,757 acres, while the area under permanent grass is greater by 33,664 acres. The land under rye-grass and other rotation grasses and clover is less

by 12,558 acres, the decrease in the area of other crops being thus 31,199 acres. The cereal crops show a total area of 1,134,864 acres, or 29,676 acres less than last year. Wheat was sown on 48,617 acres, a diminution of 832 acres or 1·7 per cent., and is the smallest acreage recorded since 1908. The area under barley, which was returned as 152,921 acres, shows an increase of 1333 acres or 0·9 per cent. Oats decreased in area by 29,540 acres or 3·1 per cent, the acreage being the smallest on record with the exception of the year 1914. The areas under beans and turnips were in each case the lowest on record, but potatoes show an increase of 3,874 acres or 2·8 per cent. as compared with the preceding year. The area under mangolds, 1,117 acres, was less than in any year since 1894, and was smaller than in 1924 by 199 acres or 15·1 per cent. Rape shows an increase of 764 acres or 6·5 per cent., but the areas under cabbage and vetches, tares, etc., for fodder were practically unchanged. The acreages under sugar-beet and flax show noteworthy increases The area under sugar-beet has risen from 196 acres in 1924 to 1,493 acres this year, while flax was grown on 753 acres as compared with 126 acres in the preceding year. Carrots and onions both show diminished acreages, but the decreases are practically counterbalanced by the increase in the area returned under the heading "Other Crops." The net decrease in the area under rotation grasses and clover is 12,558 acres or 0·8 per cent, of which the area for hay accounts for 12,225 acres, that for pasture being slightly less than last year. Permanent grass shows an increase of 33,664 acres or 2·3 per cent., the total area being 1,475,838 acres, and the largest recorded since 1915; the area cut for hay amounted to 156,244 acres, an increase of about 1·0 per cent., while the area used for pasture totalled 1,319,594 acres or 2·5 per cent. greater than in 1924. The total area cut for hay was 559,341 acres, or 10,746 acres less than last year.

The area under wheat, barley, oats and potatoes this year is, in round figures, 1,270,000 acres, which is 25,000 acres less than last year, and is the lowest aggregate recorded since the statistics were first collected in 1866.

The live stock returns show that the numbers of cattle and sheep have increased, while horses and pigs are less numerous. The decrease in horses is, as in past years, most noticeable in the "unbroken" classes, which show a total diminution of 6,208, of which 5,630 are "one year and above" and 578 are "under one year." Horses used for agricultural purposes have decreased by 608, and "other horses" by 1,447; the total decrease for all classes of horses is thus 8,263 or 4·3 per cent. Cows in milk have decreased in number by 3,930 or 1·1 per cent., but this decrease is more than compensated for by increases in the other two classes of dairy cattle, cows and heifers in calf showing increases of 3,359 and 2,534 respectively. Bulls being used for service show a slight diminution, but all classes of "other cattle" have increased in number, the most noteworthy being in the total of those of "two years and above," which are more numerous than in 1924 by 21,476 or 10·0 per cent. The total number of cattle has thus increased by 40,394 or 3·5 per cent. All classes of sheep are more numerous

than in the preceding year, the total being greater by 232,668 or 3·4 per cent., and the highest recorded since 1911. Breeding ewes have increased by 63,774 or 2·1 per cent., rams by 2,479 or 3·0 per cent., lambs by 107,975 or 5·8 per cent., and other sheep of one year and above by 58,440 or 5·9 per cent. The total decrease in the number of pigs amounts to 44,616 or 22·4 per cent.; the reduction in the case of each class is practically proportionate, sows kept for breeding being less by 7,853, boars by 846 and other pigs by 35,917.

The returns collected this year again include statistics of the acreage owned by the occupiers of the holdings and particulars relating to labour. These figures are not included in the printed abstract.

The total area of land under crops and grass owned by occupiers of holdings this year amounts to 993,593 acres as compared with 950,190 acres in 1924, showing an increase of 43,403 acres. The proportion of land returned as owned by the occupiers is 21·1 per cent., while in 1914 it was 11 per cent.

Labour employed on 4th June (exclusive of the occupiers, their wives and domestic servants) totalled 122,062 as compared with 117,342 last year, an increase of 4,720 or 4·0 per cent. Of these, 102,265 were returned as regular workers and 19,797 as casual workers, the former comprising 82,646 males and 19,619 women and girls, while the latter was made up of 10,464 males and 9,333 women and girls

Agricultural Conditions in 1925.

Weather.—Throughout the month of January 1925 the weather was generally mild with a moderate rainfall, and cultivation proceeded satisfactorily. During February, however, heavy rain fell in all districts, and farm work was considerably interrupted, but in March the rainfall was light and it was possible in most cases to overtake arrears of work. Cold weather continued during April and May, frequent heavy rains again delayed all seasonal work, and the seeding of turnips was carried out later than for many years. June and July were unusually dry and warm; haymaking operations were carried out under perfect conditions, and the condition of the cereal crops was greatly improved. Unsettled weather prevailed during August and September, but little damage was done to crops, while roots which had suffered from the drought during June and July made good progress. During October the weather was showery but unusually mild; the conditions were favourable for the lifting of potatoes and for the completion of the oat harvest in the later districts.

Wheat.—The mild weather during the winter months was favourable for winter-sown wheat, but at spring sowings the ground was rather wet and cold. Generally speaking, however, the crop did not suffer any serious check during the early stages of growth, and with the warm, dry and sunny weather in June and July, it developed rapidly. Harvest was earlier than usual and the crop was secured in good order; cutting began during the latter half of August and harvest was practically completed

by the end of September. As a result of the unusually favourable summer the grain matured well, and where threshed the samples are of good quality and of fully average weight, the yield per acre being estimated at 22·3 cwt. or 1·2 cwt. above the decennial average Smut was rather prevalent in the southern districts of Perth, but elsewhere no damage to the crop is reported either from disease or insect pests.

Barley.—The wet spring delayed the sowing of barley and germination was rather slow and irregular. In a few cases fields had to be resown owing to the ravages of grub. Warm, dry weather in June and July, however, greatly improved the condition of the crop which continued to grow vigorously until checked by drought Harvest began early in showery weather, and was rather protracted, but the crop sustained little damage. The grain generally is of good quality, and the yield is estimated to be slightly above the average, but straw is shorter than usual.

Bere, which is grown mostly in the extreme north and west, has been a satisfactory crop and was secured in good condition.

Oats.—The oat crop was so seriously affected by the wet, cold weather of the spring months that in May the prospects gave rise to some anxiety. Grub was unusually prevalent, and resowing became necessary on quite an extensive scale. The dry, warm summer, however, much improved the crop, and where it had not been seriously affected by grub earlier in the season, the plants developed very satisfactorily. Harvest was delayed by the showery weather of August and September, and some damage was caused by lodging and second growth, but in most areas the crop was secured in good condition. The yield varies considerably in different parts of the country, but almost everywhere it has proved to be much better than was expected. Taking Scotland as a whole, the produce is slightly above the average, and the grain is of good quality, but, as in the case of barley, straw is shorter than usual

Beans.—Growth was fairly vigorous throughout the season in most districts in which beans are grown. In some parts, however, the ground was rather cold and wet at the time of sowing, while in others the drought in June and July stunted growth and caused the straw to be short The pods were plentiful and fairly well filled but the beans ripened rather quickly, and the yield is estimated to be below the decennial average. In Perth some fields were badly affected by slugs and wireworm, but elsewhere the crop was generally free from disease and insect pests.

Potatoes—Early varieties of potatoes were planted under wet conditions and developed slowly, especially on light soils, owing to the dry weather that prevailed during the early summer months. Disease soon became unusually widespread, and the yield proved to be disappointingly small. The planting of maincrops was carried out later than usual. Development was at first checked by low temperatures and rain, but with the favourable conditions of the summer months the crop became vigorous and healthy. Owing to the absence of frost, growth continued into October, but with showery weather at lifting time the work proceeded slowly. The crop is reported to be unusually free from disease

and of good quality, and the yield is somewhat above the average.

Turnips.—The prospect for turnips and swedes were not very encouraging during the earlier stages of development. As a result of the wet spring, sowing was much later than usual, owing to the difficulty of preparing the ground and securing a good seed-bed. Early-sown fields, as a rule, brairded well, but on stiff soils the seed germinated badly and a considerable amount of resowing was necessary. In the case of late-sown fields the plants were slow in brairding and were late in coming to the hoe owing to the drought in June and July. As a result of the mild and showery weather during the autumn months, however, and the absence of frost, root crops made steady progress and the yield proved to be above the average. "Finger-and-toe" is present to a small extent in the north-eastern and eastern districts of the country, but in the southern, western and south-western areas the crop is practically free from this disease.

Mangolds.—Mangolds were also late in being sown owing to the wet condition of the land in April and May. The crop, however, was not checked to any extent by the drought in June and July, while the weather during the autumn was exceptionally favourable for the development of the bulbs. The roots are of good quality and a full average crop is assured.

"*Seeds*" *Hay.*—The wet weather in spring gave "seeds" hay a good start, but the growing period was shortened by the dry summer, more especially on light or sandy soils. The crop was secured under ideal conditions, and although clover was deficient, the hay was generally of excellent quality. The yield per acre was somewhat below that in 1924 but was above the average for the preceding ten years

Meadow Hay.—The reports on meadow hay are somewhat similar to those regarding "seeds" hay. The yield per acre from permanent grass was below that for the preceding year but was above the decennial average. The yield of hay from timothy meadow was slightly below the decennial average and also considerably below that returned in 1924. The hay was everywhere of unusually good quality, and the crop was secured under favourable conditions in most cases

Autumn Cultivation.—During the first half of November the weather generally was mild, and satisfactory progress was made with autumn cultivation. Frosts prevailed in most areas during the remainder of the month with local hail or snow showers, and as a result outdoor work was considerably interrupted. In consequence of the early harvest, however, stubble ploughing was almost completed and large areas of lea had been broken up before the ground became frost-bound. Mild open weather in October, moreover, had made it possible for many farmers to complete or nearly complete the sowing of autumn wheat, and in most districts at least three-quarters of the seed is sown.

Live Stock.—Grazing cattle were mostly housed before the end of November and are reported generally to be in good average condition. In North-East Aberdeen there have been considerable losses among imported beasts owing to "boat fever." Dairy cows

are healthy and thriving and, although reports on the milk yield vary considerably, the supply in most districts is normal for the season. Sheep generally have done well and in some counties the stocks are reported to be in very good condition.

Labour.—The latest reports indicate that the supply of regular and casual workers is sufficient for present needs except in Kincardine, South-West Perth and Dumfries, where there is a slight scarcity. Skilled drainers are required in Dumbarton and women workers are scarce in Orkney and Central Argyll, while in Central Perth, Kintyre, Bute and North Ayr experienced dairy workers are rather difficult to secure.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from the publications of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Board of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

The Correlation of Characters in Hybrids of Wheat. *Thompson, W. P., Genetics, Vol.* 10, *No.* 3.—The following is an extract:—

Thirteen pairs of characters which distinguish hard wheat (*Triticum durum*) from ordinary cultivated wheat (*T. vulgare*) were studied in the first and second generation plants.

The *durum*-like segregates commonly showed one or a few *vulgare* features, sometimes even the most characteristic ones. Similarly, the *vulgare*-like segregates showed commonly one or a few *durum* features.

The intermediate plants showed a high degree of sterility and produced a high proportion of *durum* and *vulgare* types in the third generation. Intermediate types thus tend to disappear in the third and later generations.

Results are given concerning the inheritance of rust-resistance in this cross. Records are available for more than 3,000 second generation plants and third generation families (about 30,000 plants in all), and these show the second generation ratio of susceptible to resistant to be about 13 : 1 of the resistant plants; very few were of the general *vulgare* type, though numerous resistant plants contained a few *vulgare* characters. The few resistant *vulgare*-like plants were not so resistant as the *durum* parent. The correlation of rust-resistance and *durum* characters has been broken, but, owing to the fact that it depends on more than one factor, it may be very difficult to get the full *durum* resistance in *vulgare* types without other *durum* characters.

Extract from Annual Report of the Activities of the Swedish Seed Association in 1924.—Economically the Association was fortunate during the year; the weather for purposes of research was better than in the previous year, but not altogether satisfactory.

Details are given of Swedish crops in 1924.

A copy of a paper by Mr. Rob. Forssell which was read and discussed at a meeting of the Agricultural Society's Experiment Directors is included in the Report. In this paper, which deals with the testing of cereals, advice is given as to the principle on which the quantities of seed should be sown, and emphasis is laid on the points whether the seed is early and germinative. The disadvantage of very narrow plots is that the straw of the neighbouring plots may lean over and affect the other. To obviate this there should be a protecting belt a yard wide. The seed should be sown in such a direction as to give all types as nearly as possible an equal share of good and poor soil.

Harvest, Threshing, etc.—Each type should be harvested at its proper time. It is a mistake to cut down the whole field irrespective of the ripeness or otherwise of the different types of corn. The harvest from each plot should be put

into special sacks to obviate loss. Large threshing machines should be avoided for test grain, small non-cleaning or semi-cleaning machines being preferable. The grain should be tested for both quantity and quality, also for moisture. Threshing of the different types should be carried out as nearly as possible at the same time.

France: Regulation of the Trade in Cereal Seeds.—With the presidential decree of 26th March 1925 the selling of wheat seed packed in any other than the prescribed way is forbidden. The labels on the packages must bear information as to the variety of wheat, its origin and the average percentage of this wheat in the package. Only such wheat may be sold as first class or choice seed, and that which is obtained by individual selection must contain not more than 1 per cent. of seeds of other varieties than the one indicated. The germination capacity of the wheat, when not specified, must not be less than 85 per cent.—(*Bulletin de l'Office de renseignements agricoles, No.* 7, 1925.)

Dust Treatment for Control of Oat Smut (*Ustilago Avenæ* and *U. Levis*). *Thomas Roy, C., Science, n. ser., Vol. LXI. No.* 1567. *Lancaster, Pa.,* 1925.—In the investigations on the control of oat smut (*Ustilago Avenæ* and *U. levis*), dust treatment tests in the past have given variable results. While mixtures containing copper and nickel, in the form of dust, have almost always greatly reduced smut, their efficacy has not always proved such as to warrant the general use of dust treatments.

The result of three years' tests in Ohio is that neither compounds of copper nor those of nickel, used alone or as dust, are sufficient to control oat smut. On the other hand, in combination with corrosive sublimate, the mixture proved to possess a value which compares very favourably with formaldehyde.

In treating the seed it is not only desirable that the fungicide used prove effective against smut, but also that seed germination be stimulated or, at least, not weakened. By the use of compounds of copper or nickel (carbonate, sulphate and acetate of copper, and carbonate of nickel) combined with corrosive sublimate, the seed germination was stimulated to a marked degree, which is not the case with the formaldehyde treatment.

In the preliminary tests one part of the salts of copper or nickel and two (by weight) of corrosive sublimate were well mixed and powdered. Three ounces of the mixture per bushel of seed were used. Corrosive sublimate used alone proved to possess but very slight adhesive properties; moreover, owing to its relatively high cost and extreme toxicity it would be less readily used alone than with some other compound which might serve as a vehicle. The fundamental idea is to add to the salts of copper or nickel just enough corrosive sublimate to raise the power of the mixture to the required degree for the control of oat smut. Further experiments are necessary in order to ascertain more accurately the minimum quantity of the salts which may be effectively used, bearing in mind also the reduction in cost.

Potatoes: Germany.—The *Illustrierte Landwirtschaftliche Zeitung* has published a special number on potatoes (No. 11, 1925). This *Kartoffel Sondernummer* contains articles by Dr. L. W. Ries on the use of implements in weeding; by the agricultural expert G. Schalk on the possibility of doubling the yield of potatoes; by Prof. Appel, Director of the State Biological Institute at Berlin-Dahlem, on the measures for prevention of abnormal sprouting of the potatoes; by Prof. Dr. O. Heuser on the degeneration of potatoes and preventive measures; O. Staudte of Breslau on the fertilisation or pollinisation of the potato flower; by Dr. Nichtweis, agricultural administrator in Silesia on the methods of storage of the potato by the construction of special store-houses; by Prof. Opitz of the High School of Agriculture in Berlin on the influence of fertilisers in potato-planting. In addition there is an article by Herr Knorr of Vornstedt (Mark) on the annual report of the German Potato Research Station (Deutsche Kartoffelkulturstation) and the results reported therein concerning the inquiries of that station during the year 1924; an article by H. Morgen of the Agricultural Institute of Giessen on the percentage of starch in relation to the successive production of the same variety of potatoes through succeeding generations; by Mr. Kohlmeier of Mecklenburg on the determination of the forms of tubers of potatoes. The articles are illustrated. The usual supplement to the *Illustrierte Landwirtschaftliche Zeitung*, the *Blätter für die deutsche Hausfrau* is also devoted to potatoes in this number.

The Importance of the Cultivation of Roots in the Organisation of Farming. *Meunzinger (Hohenheim). Die Bedeutung des Hackfruchtbaues für die Betriebsorganisation, Mitteilungen der D. L. G., XL. Year, No.* 11. *Berlin, March* 1925.—High cost of labour, low prices of farm products, lack of working capital and credit, are characteristic of the present condition of German agriculture. It is not surprising that many farmers, owing to the necessities of the moment, try to force their soils to yield more, even if by this expedient they damage the future prospects of their farms.

The author's object is to show that the cultivation of roots, though the cost of labour is more and the return less than more expensive crops, is yet absolutely indispensable for the general good of all the crops in the rotation, and that without roots the other crops will produce less.

The author shows by means of tables the average cost of production for each crop grown on the farm of the Agricultural High School at Hohenheim over a period of 30 years. As a unity of measure for the work done he does not employ monetary unities but "normal men-days" (woman's work = ⅔ man's day) and "normal horses'-days" (4 oxen = 3 horses).

Costs of production per ha. in men-days and horses-days.

Roots	121	50
Rape and leguminous parts	61	30
Wheat	30	20
Meadow-land	25	11

It is seen from this that roots require more labour, both from man and team, and that the cost of roots is three times as high as for corn.

Labour is no doubt to-day the greatest expense in farming; after it comes manuring. Here, too, roots are the most expensive of all, rape and leguminous plants occupy the second place, corn the third and meadow land the fourth.

The author then considers the cost of the seed of the different crops, in which relation also, potatoes with a cost five times as high as that of wheat present an unfavourable result.

The costs are compared with the gross monetary returns. Over an average of 30 years at Hohenheim there were harvested :- 27·3 double quintals of wheat; 27·0 double quintals of oats; 175 double quintals of potatoes; 300 double quintals of sugar beets. If the total cost is compared with the rough produce, it results that the relation of cost to gross return of money is :—

Crop.	*Total Cost.*	*Gross return.*	*Excess of return over cost*
Wheat	352	630	278
Oats	320	472	152
Potatoes ...	854	918	64
Sugar beets ...	836	960	124

It must be stated that the Hohenheim soils are decidedly corn soils and are not good potato soils, which makes the results somewhat unfavourable to the latter.

The data show that the cost is so high with roots that, if marketable products only are considered, their gross profit remains far behind that of cereals, particularly wheat. The difference becomes still more unfavourable when the relation of expense to gross profit surplus is considered, for example :-

Wheat	100 : 79
Oat	100 : 48
Potatoes	100 : 8
Sugar beets	100 : 15

Hence, wheat and oats, with a minimum of risk and the smallest expense yield relatively the largest surplus. But they are only favourable—and therein lies the invaluable character of root crops, which does not appear from the figures—when corn is grown in rotation with roots. If the influence of roots were eliminated, such high yields for wheat and oats (an average of 31·5 double quintals, relatively 33·7 double quintals in the last 12 years) could never be attained. The result would then be quite different, for without roots the soil would need such quantities of artificial manure that it would soon be impossible to increase the yield of cereals by forced increase of artificial manuring.

Replacing the expensive potatoes or the sugar beets by rape or leguminous plants does not have so good an effect, nor is the result so certain. Laying down a large extent of land to grass is only advisable where the soil makes such

a course necessary. To change good arable land into meadow land would be short-sighted and would alter the general relation of prices, to the disadvantage of cattle production, to which the farmer who had followed this policy would turn.

In considering the unfavourable figures shown actually by roots, one must not overlook the advantages to other crops of the cultivation of roots, and therefore the words of Rumker concerning the cultivation of roots are still perfectly justified, "The cultivation of roots is the base and the lever for the introduction of a higher and more intensive cultivation of the soil, for larger yields of the land and an increased production of cattle. It is the high school of modern intense agricultural development, and hence one of the most important factors of the possibility of supplying by our own production our requirements in bread and meat. Whosoever raises the axe against this point and damages this base of our existence, does us a vital injury."

Inheritance Studies in Pisum. V., The Inheritance of Scimitar Pod. *White, Orland E., Genetics, Vol.* 10, *No.* 3.—The results are summarised by the author as follows:—

1. The first, second and third generation results of crosses between eight different varieties of peas, breeding true to broad, straight, or broad slightly curved pods, and a single variety, Graue Riesen Schnabel, with narrow scimitar-curved pods, are described in detail as respects the inheritance of the scimitar character.

2. In the first generation the broad-pod character is nearly dominant. In the second generation two segregate classes are easily distinguishable,—broad, straight, or broad, slightly curved-pod types and narrow scimitar-pod types,—in a ratio approximating 3 : 1.

Rumania: New Regulation for Wheat, Flour and Bread.—Legislative measures are published in No. 4 of the *Monit. off.* (6th January 1925), by which the exportation of wheat and its derivatives is prohibited. The national mills are obliged to recover from the wheat integral flour to the extent of 85 per cent.

In time of urgent need, or war, the Government is empowered to seize all wheat and flour required to supply the needs of the population or army. Maximum prices are fixed for wheat standard flour, for the flour already in store, and also for the above-mentioned Government requisitions.

SOILS.

The Aluminium Content of the Soil Solution and its Relation to Soil Reaction and Plant Growth. *O. C. Magistad, University of Wisconsin, Soil Science, XX,* 3, 181 (1925).—The investigation was undertaken to determine whether the injurious effect of acidity on certain plants is due to the toxic effect of soluble aluminium or to the degree of acidity of the soil The results obtained indicate that both causes can operate. Under very acid conditions the plants under observation appeared to suffer both from the toxicity of soluble aluminium and from high acidity.

Under moderately acid to slightly acid conditions some plants—including barley and soy beans—appeared to suffer from the effects of aluminium, whilst others, such as alfalfa, red clover, rye and oats, did not. The benefits obtained by the use of lime in the latter group of plants results from the decrease in acidity; in the case of barley and maize from the decrease in soluble aluminium as well as reduction of degree of acidity; and in the case of soy beans the beneficial effect appears to be due chiefly to reduction of the amount of soluble aluminium.

In the case of strongly alkaline soils the solubility of aluminium is very considerable, and it is suggested that this is one of the reasons why very alkaline soils do not support good plant growth.

Base Exchange in Relation to the Problem of Soil Acidity. *G. W. Robinson and R. Williams, Trans. Faraday Society, XX,* 586 (1925).—In certain cases soils which show a "lime requirement" by the ordinary methods in use at present are quite fertile and do not respond to liming. These soils generally contain considerable amounts of easily exchangeable calcium. On the other hand soils which respond to liming have usually been found to contain very small amounts of easily exchangeable calcium.

A Critical pH for the Formation of Hardpan in Acid Clay Soils. *John R. Skeen, University of Pennsylvania, Soil Science, XX*, 4, 307 (1925).—The relation between degree of solidity and the formation of hardpans was studied in a number of acid clay soils, and the conclusion was reached that in these soils pan formation took place in strongly acid conditions and over a comparatively narrow range of acidity (pH 4.7 to pH 4.95).

The hardpans studied were mostly due to cementation by iron and aluminium, and experiments carried out in the laboratory confirmed in a general way the conclusion arrived at in respect of the acidity at which the cementation occurs.

The Disintegration of Limestone and Dolomite Separates as Influenced by Zone of Incorporation. *W. H. MacIntire and W. M. Shaw, University of Tennessee Agricultural Experiment Station, Soil Science, XX*, 5, 403 (1925). —The experiments were carried out in lysimeters or drain-gauges and were continued for four years. Limestone and dolomite ground to various degrees of fineness were mixed with the surface layer of soil in certain cases and with the sub-surface layer in others. Control tanks for comparison contained untreated soil, and soil with hydrated lime with calcined dolomite and with a mixture of calcium and magnesium oxides. The soil used for the experiments was a slightly acid brown loam. The results obtained showed that the limestone disintegrated more rapidly than the dolomite and the difference was most marked in the coarsely-ground material. Fineness of grinding was very important in all cases. Only a very small amount of the 10-20 mesh limestone in the surface layer of soil was decomposed, but in the sub-surface layer eight times as much (or 51.8 per cent.) of the same grade of material was decomposed. The more finely-ground grades of material showed a much greater disintegration. About 85 per cent. of the 20-40 mesh, and practically the whole of the 40 80 mesh and 80 200 mesh limestone had disintegrated even in the surface layers at the end of four years. Very finely-ground carbonate of lime would therefore appear to be as available as burned lime, and the control experiments seemed to confirm this.

In every case the sub-surface layer of soil brought about a greater decomposition than the surface layer, and this has been attributed to the presence of a greater amount of moisture in the sub-surface layer, and to the fact that the sub-surface moisture is more heavily charged with carbon dioxide.

The Exchangeable Bases in some Scottish Soils. *A. M. Smith, Edinburgh and East of Scotland College of Agriculture, Journal of Agricultural Science, XV*, 4, 466 (1925).—A proportion of the bases present in any soil is in an exchangeable condition, and may be brought into solution and made available for plants by the addition of any other base in the form of a salt or fertiliser. Determination of these bases have revealed some interesting variations in their total amounts and relative proportions for a number of soils from different parts of the East of Scotland. Those variations may be due either to fundamental soil differences or to the secondary effects of cultivation and manurial practice, but there are indications that similar applications of fertilisers would have markedly different effects upon different soil types, and that a classification of soils and a thorough examination of the groups might throw some light upon the actual needs of any particular soil.

Experiments with Sub-Soiling, Deep Tilling and Sub-Soil Dynamiting. *Bulletin* 258, *Illinois Experimental Station.*—It was found in the experiments carried out that deep ploughing, sub-soiling and dynamiting did not materially increase crop yields. On these particular soils, at any rate, ordinary to medium depth ploughing was all that was required.

Residual Effects of Forty Years' Continuous Manurial Treatments: Effect of Caustic Lime on Soil treated with Farmyard Manure. *J. W. White and F. J. Holben, Pennsylvania State College, Soil Science, XX*, 4, 313 (1925).—With the exception of the first rotation, the plot treated with lime and manure has given a greater field throughout the forty years than the unlimed plot—the total increase amounting to 13,120 lbs. of dry matter. It is estimated that 93 per cent. of the organic matter of the lime and manure plot is derived from crop residues, compared to 88 per cent. on the plot treated with manure only.

The burned lime did not cause an excessive decomposition of organic

matter as indicated by the earlier studies, but on the other hand the increased yields due to lime left in the soil a balance of organic matter derived from crop residue. The rate of decomposition of manure on the limed plot was 5,428 lbs. per acre per annum compared with 5,071 lbs. on the unlimed. Although the decay of applied manure in the limed plot was 2,900 lbs. greater than in the unlimed manured plot during forty years, the liming resulted in increased crop yields which left in the limed plot a balance of 1,345 lbs. of organic matter in excess of that in the unlimed manured plot.

The application of lime to the manured soil has resulted in the fixation of 294 lbs. of nitrogen in excess of the unlimed similarly manured soil, and 508 lbs. in excess of the untreated soil.

Burned lime is compared with ground limestone, and it is found that more decomposition of organic matter took place on the limestone than on the burned lime plot, and that the limestone plot had produced more nitrogen. These results are explained as being due to greater bacterial activity in the ground limestone plots.

FERTILISERS.

Fertiliser Tests with and without Ground Limestone. *Blair, W. S., Scientific Agriculture, Vol. No. 6. Ottawa,* 1925.—The test was started in 1914 to ascertain the most profitable source of nitrogen and phosphorus ; on a similar series of plots ground limestone was applied to gain information as to its value when used in conjunction with such fertilisers. A three-year rotation of potatoes, grain, clover and timothy hay was followed.

Potatoes are not a good crop for experiments in which lime is continuously applied, owing to the fact that it favours scab, which in this case reduced the market value of the crop. In every instance there was a marked increase in yield of the limed over the unlimed plots.

Nitrate of soda gave slightly better results than sulphate of ammonia. On the unlimed sulphate of ammonia plots acidity increased. Basic slag gave slightly better returns than acid phosphate. Limestone was of greatest benefit to clover and to the hay crop. Wheat responded in a marked degree to lime. Limestone should not be applied to a potato crop. To apply when sowing with grain is advisable.

Limestone more than doubled in quantity the hay crop and gave hay of better quality. Its use enables clover to be grown on soils which otherwise would not grow this crop.

France : Repression of Fraud in the Fertiliser Industry.—The decree of March 19th, 1925, supplements the former law of February 1888. Regarding the repression of fraud in the fertiliser industry, it is prescribed that all commercial documents together with the labels on the packages must state full details as to the chemical substances contained in the fertiliser in order to protect the purchaser from fraud. –(*Journal Officiel, 22nd March* 1925.)

ANIMAL NUTRITION.

The Effect of Bone Meal on Growth of Dairy Heifers. *W. D. Salmon and H. E. Eaton, J. Dairy Science, viii,* 312, 1925.– A number of papers have been published on the effect of feeding supplementary mineral compounds on the milk production of cows, but the data on their effect on growth are scanty. Theiler in South Africa has found that the feeding of bone meal has a very favourable effect on the gains in weight of cattle grazed on soils containing little calcium and phosphorus, while Hart in America reports that the addition of bone meal and cod liver oil to a cereal ration gave marked improvement in growth and reproduction in dairy cows.

The present experiment was carried out to test the effect of adding bone meal to a commonly used farm ration. Two groups of 4 heifers, 3 Jerseys and 1 Holstein, weighing at the beginning of the experiment from 300 to 460 lbs., were used. Both groups received a grain ration (shelled corn and oats) and hay and had access to salt blocks. One group received in addition 2 ozs. steamed bone meal per day. The experiment lasted for 18 periods of 28 days each, and during the grazing period the heifers were on pasture with a low lime content.

No actual figures are given of the individual increases in weight of the heifers, but growth curves are shown from which it is seen that the addition of

the 2 ozs. of steamed bone meal per animal per day had no decided effect on the growth of the heifers. The Jerseys receiving the bone meal grew slightly faster than those that did not receive the bone meal, while the Holsteins showed exactly the reverse.

In view of the fact that the ration and the pasture were both deficient in calcium it was confidently expected that the feeding of bone meal would be advantageous, but it is suggested that the effects of the mineral feeding will be reflected in the milk production or that it will show up in later generations.

The Effect of Cane Molasses on the Digestibility of a Complete Ration fed to Dairy Cows. *P. S. Williams, Journal of Dairy Science, Vol.* 8, *No.* 2, 1925.—In one early American trial it was found that cane molasses in a ration depressed its digestibility, while in another a beneficial effect was found.

In the trial at present under review four cows were used. They were fed a basal ration of hay, silage and mixed concentrates. There were nine periods of 21 days each, the first 10 days of each period being looked on as transitional and the results discarded. In three of the periods the basal ration was fed, in three the basal ration with sufficient molasses to provide about 5 per cent. of the total dry matter, and in three the basal ration and sufficient molasses to provide about 10 per cent. of the dry matter.

There was no specific influence on the milk yield. The addition of the molasses depressed the digestibility of the crude protein and dry matter, but had no uniform effect on the digestibilities of the crude fibre, soluble carbohydrates and fats.

The Influence of Small Quantities of Potassium Iodide on the Assimilation of Nitrogen, Phosphorus and Calcium in the Growing Pig. *Kelly, F. C., Biochem. J., XIX, Pt.* 4, 1925.—It is now recognised that iodine in very minute quantities is one of the essential mineral elements in human and animal nutrition, and much work is now being done on this subject both from the point of view of estimating its effect on general metabolism and also, more particularly, its nutritional effect in stimulating growth.

Kelly in the above paper has recorded the results of four metabolic experiments in which small quantities of iodine (0·5–0·0039 grms. per day) in the form of potassium iodide were fed to pigs, a control lot receiving no iodine. The intake in the food and output in the fæces were determined, and it was found that administering these small amounts of iodine to pigs fed on a diet of cereals led to an increased assimilation and retention in the body of nitrogen and phosphorus. There was also evidence of an increased retention of calcium.

Evvard and Culbertson in a pamphlet "Studies in Iodine Feeding," *Iowa Research Bull* 86, 1925, besides giving an excellent concise synopsis of the literature on iodine and its function in nutrition, give the results of three experiments in which the effect on growth of the addition of small quantities of potassium iodide (0·01–0·1 per cent. of a supplementary mineral mixture) to a pig's ration was determined, a control group in each experiment receiving no iodine.

The average daily gain in weight per pig for the three experiments was for the control group 1·372 lbs., and for the iodine group 1·508 lbs., while the food consumed per 100 lbs. gain in weight was for the control group 450 lbs. and for the iodine group 405 lbs.

The feeding of minute quantities of iodine to pigs thus resulted in an approximate 10 per cent. increase in average daily gain in weight, and a 10 per cent. decrease in food consumed per 100 lbs. gain in weight.

Great care should be exercised in the feeding of iodine to animals as much harm may be done by feeding excess. The physiological requirements of each species vary, are unknown, and the amounts fed in these experiments were arbitrary.

Report on Pig-Feeding Trials carried out at the County Council Farm, Hutton, Lancashire, 1920–23. *J. J. Green and R. Richardson*, 1924.—This report gives the results of eight different experiments to determine the value of certain feeding stuffs when fed to pigs, and the comparative values of different methods of feeding. Some of these are summarised below.

(a) *The value of fish meal as a feeding stuff for pigs.*—Two groups of pigs received a ration of sharps, maize meal and whey, one of the groups having one part fish meal substituted for one part maize meal. The average initial weight per pig was 58 lbs. in both groups. At the end of 16 weeks the average weights

were :—Fish Meal Group 158 lbs., with an average daily gain of 0·9 lbs.; No Fish Meal Group 151 lbs., with an average daily gain of 0·83 lbs. The lbs. of meal and meal equivalent required to produce one pound live-weight gain were for the Fish Meal Group 4·05 lbs., and for the No Fish Meal Group 4·4 lbs.

The most striking fact about this experiment was that the six pigs receiving no fish meal all suffered from lameness, owing no doubt to the lack of mineral matter in the diet. The group receiving fish meal showed no signs of lameness.

(b) *The value of whey for pig feeding.*—Three groups of pigs were fed a basal ration consisting at first of thirds and maize, to which were added later palm-kernel cake meal and a little bran. This basal ration was fed to Group I. with water; Group II. received in addition a daily allowance of whey commencing with ½ gallon and rising to 1½ gallons; Group III. had one part of maize meal replaced by one part fish meal. By the end of the tenth week Groups I. and II. were seen to be suffering from lameness, and for the remainder of the experiment received a supply of a mineral mixture. Over a period of seven months, Group I. gained on an average 180 lbs. with a food consumption of 4·8 lbs. per 1 lb. live-weight gain: Group II. gained 201 lbs., consuming 4·6 lbs. food per 1 lb. gain; Group III. 224 lbs. with a food consumption of 4·5 lbs per lb. gain in weight. The effect of the whey was most noticeable during the earlier stages of the experiment, when the whey-fed pigs had a more thrifty appearance and made 50 per cent. better progress than the pigs receiving basal ration alone. This advantage, however, was lost later.

(c) *The value of palm-kernel cake meal for pig feeding.*—The object of the experiment was to compare palm-kernel cake meal with sharps as part of a ration for pigs. Palm-kernel cake meal is very similar in composition to sharps, but is considerably cheaper.

Group I. received a ration of four parts sharps, three parts maize meal, one part fish meal, with an allowance of whey. Group II. received the same ration with four parts palm-kernel cake meal substituted for the sharps. Over a period of five months, Group I. showed an average increase of 266 lbs. per pig (1·32 lbs. per day), while Group II. showed an increase of 278 lbs. per pig (1·42 lbs. per day). The amount of food required to produce 1 lb. live-weight increase was for Group I. 4·97 lbs., and for Group II. 4·76 lbs. The pigs fed on palm-kernel cake meal showed nearly £1 per head more profit than those fed with sharps.

The palm-kernel cake meal used in this experiment, the oil from which has been extracted by pressure, has to be distinguished from palm-kernel meal, an inferior feeding stuff, from which the oil has been extracted by solvents.

(d) *Relation of weight of pigs to food consumed and rate of gain.*—During the course of these experiments a considerable amount of data had accumulated showing the amount of food consumed by the pigs and the gains in weight made, and these records have been used to show the amount of food required by pigs of different weights to produce 1 lb. live-weight increase. A table is given which shows that to produce 1 lb. increase in pigs of 2-4 score just under 4 lbs. of food is required. As the pigs get heavier more food is eaten, but the rate of increase in weight is not in proportion to the additional food consumed, so that at 8-10 score 4·7 lbs. and at 16-18 score 6·4 lbs. of food are required to produce 1 lb. live-weight gain. These results indicate the wisdom of supplying to the bacon curer a pig of about 13 score lbs. live-weight rather than to continue feeding to a heavier weight.

The Value of Sugar Beet and its use as a Foodstuff. *Nils Hansson, Report No.* 251. *From the Central Institute for Research in Agriculture, Animal Division, No.* 38. *Stockholm*, 1923.—The Department of Animal Industry of the Swedish Agricultural Experiment Station has carried on some feeding experiments during the winter months of 1922-1923 with the object of determining the fodder value of sugar beets for different kinds of farm animals. The beets used for the experiments contained not less than 23·41 per cent. and not more than 24·76 per cent. of dry matter, the sugar percentage varying between 17·16 per cent. and 18·15 per cent. In five feeding experiments with draught horses the beets have been used in place of oats in proportion of 1 food unit of oats to 1·04–1·09 kg. dry matter of sugar beet, to which has been added a small quantity of soya bean meal or soya bean cake in order to regulate the percentage of protein in the sugar beet mixture. In two feeding experiments with fattening pigs the sugar beets have been used in place of barley in proportion of 1 kg. ordinary barley to 1·06–1·09 kg. dry matter of sugar beet. Finally,

in two experiments with milch cows the sugar beets have been used in place of swedes and common beets.

The following conclusions are drawn from feeding experiments :—

(1) That properly cleaned sugar beets are very serviceable as fodder both for draught horses, fattening pigs and milch cows, all of which eat them with relish;

(2) That sugar beets have in all cases good dietic properties and may be used in considerable daily portions. In the experiments described they have amounted to as much as 15–18 kgs. for draught horses, 19·5–23 kgs. for milch cows, and 4·6 kgs per day and head for fattening pigs;

(3) In the fodder rations for draught horses, when the protein percentage is regulated by addition of fodder rich in such substance, the food value of sugar beets may be computed at 1·05 kg. dry matter of sugar beets to 1 food unit of oats. The food value of sugar beets seems to be somewhat higher when the daily rations are limited from 10–12 kgs.;

(4) Under the same conditions regarding the protein percentage it has been found that 1·05–1·10 kg. dry matter of cut-up sugar beets will replace 1 kg. of ordinary barley as fodder for fattening pigs. The sugar beets have in this case had a favourable effect in regard to the firmness of the pork;

(5) That the dry matter of sugar beets when fed to milch cows has on the whole the same value as the dry substance of swedes and common beets. However, when feeding with sugar beets the fat percentage of the milk has diminished on an average 0·06 per cent. to 0·07 per cent.

DAIRYING.

Carbonation of Butter. *Prucha, Brannon and Ruehe, Journal of Dairy Science, Vol.* 8, *No.* 4.—Carbon dioxide is extensively used in the preparation of non-alcoholic beverages, and attempts have been made to extend its use to dairy products under the assumption that spoliation due to bacterial action would be minimised. The authors as a result of a series of tests with CO_2 applied to sweet cream and to butter have found carbonation to be of little benefit. When CO_2 was pressed into cream at a pressure of 5 lbs. for three minutes it exerted only a slight amelioratory effect on the keeping qualities of the cream. Neither when the air in the churn during churning time was replaced by CO_2 did any benefit accrue. Indeed carbonated butter had a sourish taste immediately after churning. No beneficial effect in the keeping quality of the butter was recorded But butter stored in air tight containers in an atmosphere of CO_2 was free from mould and showed slightly enhanced keeping properties.

Cleaning Milking Machines. *L. H. Burgwald, Journal of Agricultural Research, Vol.* 31, *No.* 2, 1925.—This is a report of comparisons that were made of three of the methods most generally used for sterilising milking machines—heat, chlorine, and salt and chlorine.

The machines were cleaned after milking and then sterilised as follows:—
(1) In chloride of lime solution. (2) In a solution of salt and chloride of lime. (3) Placed in water at 160° F. to 165° F. for 20 to 30 minutes just before milking and kept in clean water the rest of the time.

The trial lasted about six months, and the various machines were rotated among the cows so that each machine milked the various cows about the same number of times. Part of the time the machines were used for two milkings per day and part of the time for one milking.

It was found that the heat resulted in the milk having more uniform and appreciably lower bacterial counts than were obtained with the other methods. The chloride of lime and salt and chloride of lime methods of sterilisation were of about equal value during cold weather. In warm weather, however, both methods were of lower value than in cold weather, though under those conditions the salt and chloride of lime method gave much better results than the chloride of lime alone. The salt and chloride of lime corroded the metal parts of the machines to some extent.

It is recommended that fresh solutions of chloride of lime or of salt and chloride of lime be made up once weekly in cold weather, but in warm weather the chloride of lime solution should be made up daily and the salt and chloride or lime solution every other day.

Destruction of Bacteria in the Roller Process of Milk Drying. *Hunwicke and Jephcott, Journal of Dairy Science, Vol.* 8, *No.* 3.—The roller process of milk drying, when carefully controlled, destroys completely the non-sporing bacteria in milk. But spores and spore-bearing bacilli are not uniformly destroyed by the process. On the other hand, the roller process of milk drying is incapable of either destroying or rendering non-virulent the tubercle bacillus, both of human and bovine origin. The authors also found that dried milk adequately prepared by the roller process from highly tuberculous milk is incapable of causing tubercular lesions in the guinea-pig.

Pasteurisation of Milk. *Henri Stassano, Le Lait, Vol.* 5, *No.* 45.—Stassano reports on a new type of film pasteuriser which has a capacity of 400 gallons per hour, and a heating surface of 11-12 metres. It is easily cleaned. The milk in the form of a film or fine layer is brought into contact with the heating surface for 11 seconds over a surface of 11 linear metres, and in unit time only five litres of milk are spread over this large heating surface. The temperature of the heating surface need not exceed the desired temperature of pasteurisation by more than two degrees. By this method the milk may be heated to 75 to 80°C. This ensures the complete destruction of the tubercular germs. Milk treated by this device is like raw milk, the milk bacteria are almost completely destroyed, and the odour and taste are unimpaired. The treated milk keeps for five days if stored in clean receptacles.

Reducing the Losses of Butter-fat in Butter-milk. *Ruehe and Steritz, Journal of Dairy Science, Vol.* 8, *No.* 4.—Losses of butter-fat in butter-milk are often considerable, and the authors have found an average loss of 0·914 per cent. in 57 samples taken from Illinois Creameries. Even when care is exercised in the process of manufacture, the loss is commonly over 0·5 per cent. Ruehe and Steritz show that the loss can be reduced on an average by 0·26 per cent. if 1 per cent. salt is added to the cream before churning, and by 0·4 per cent. if the cream is slightly acidified with hydrochloric acid added at the same time. A combination of salt and hydrochloric acid is still more effective in reducing the normal loss of butter-fat in the butter-milk Adding breaking water does not apparently exert any effect on the butter-fat content of butter-milk.

Thickening of Condensed Milk. *Downs, Journal of Dairy Science, Vol.* 8, *No.* 4 —Sweetened condensed milk usually flows freely from the can, has a creamy flavour, and a pleasing odour and taste. Sometimes, however, it is so thick that the can contents will not flow without vigorous shaking, at other times the condensed milk appears to be quite solid. This thickening may be due either to the effect of heat treatment or to ageing, in which case the taste and smell remain normal, but when the thickening is accompanied by a fruity odour and a disagreeable taste, it is due to rennet-like enzymes produced by bacteria of the *Staphylococcus pyogenes albus* type (non-pathogenic variety). The thickening organisms possibly come from the atmosphere; they are not common in fluid milk, but condensed milk seems to act as a differential medium well adopted for their development.

Frazier shows that organisms of the potato bacillus group can produce rennet-like enzymes in amount sufficient to favour the coagulation of milk on sterilization.

Rationing of Dairy Cows. *Departmental Committee Report, Ministry of Agriculture and Fisheries*, 1925.—Milk recording has done much to advance the interests of dairying, but undoubtedly, as is suggested in this report, the greatest possible advance cannot be made through milk recording unless the feeding of the cows receives attention at the same time. In some of the English milk recording societies systematic rationing of the cows is practised to a certain extent, and the report under review recommends the extension of this practice.

The committee preparing the report state "that the general administration of a scheme of advice on rationing, uniform in its main principles, is both practicable and desirable. We have accordingly outlined in our report the type of scheme which we consider might usefully be adopted." The main features of the scheme are :—

"(i) Utilisation of the existing milk recording societies as extensively as possible, more especially for the purpose of obtaining such information as is required by advisers (usually the respective county agricultural organisers) to enable them to give sound advice to farmers.

"(ii) Application of standard values, assessed on a uniform basis, to the home-produced foods fed by the farmer when advising him as to the cost of his ration.

"(iii) Adoption of agreed scientific standards of feeding for maintenance and production.

"(iv) Importance of personal touch between the adviser and the advised, secured by the farmer paying as many visits as possible to the farm.

"(v) Recording and summarising the results obtained over a definite winter period, thus enabling comparisons to be made between individual farms and over the several counties."

Yeast as a Supplementary Feed for Lactating Cows. *C. H. Eckles and V. M. Williams, Journal of Dairy Science, Vol.* 8, *No.* 2, 1925.—Little is known about the requirements of dairy cattle for vitamines. This report deals with a study of the influence of vitamine B on the milk production of cows. Two groups of four cows each were fed by the reversal method. The basal ration consisted of maize silage, dried beet pulp, lucerne hay and a concentrate mixture containing ground maize, ground oats, wheat, bran and linseed oil meal. During the experimental periods 25 grams of dried yeast per cow per day was added.

The basal ration used is one quite rich in vitamine B, and as the addition of the yeast, which contains a large amount of vitamine B, had no influence on the milk production of the cows, it would appear that the provision of an excess of vitamine B is of no value to dairy cows.

LIVE STOCK—*Poultry.*

The Influence of Ultra-Violet Light on Leg Weakness in Growing Chicks and on Egg Production. *Hughes, Payne and Latshaw, Poultry Sc., Vol.* 4, *No.* 4, *p.* 151, 1925.—Repetition of a previous experiment has confirmed the beneficial influence of ultra-violet light in the prevention of leg weakness in growing chickens. Blood and bone analyses showed a higher calcium and phosphorus content in the case of the irradiated as compared with the non-irradiated chicks.

For egg production three groups of 12 Leghorn pullets received a similar ration of corn, tankage, casein, butter and bone ash with an *ad lib* supply of sprouted oats. Pen I. received ultra-violet light for 10 minutes daily for 16 weeks; Pen II. was kept in a well lit room with no direct sunlight; Pen III. was kept outdoors exposed to sunlight. Before the experiment commenced no significant difference was found in the egg production of the three groups. The production during the 16 weeks of the experiment was as follows: Pen I., 497; Pen II., 124; Pen III., 617 eggs.

The beneficial action of light was also shown in the chemical composition of the egg: the weight of calcium in the shell and the percentage calcium and phosphorus in the contents being higher in the irradiated pen and the pen receiving direct sunlight than in the pen receiving no direct light. Half the birds in Pen II. died during the experiment, all showing the symptoms of leg weakness.

The light treatment in Pen I. was discontinued and begun in Pen II., when the previous order of egg production of the two pens was reversed, while no further deaths took place in Pen II.

The eggs having the highest calcium content hatched best, but it was not believed that this was due to the percentage calcium, but to a variation in the antirachitic vitamin content. Another factor believed to affect the hatchability is the amount of sunshine just preceding and during the time the egg is produced.

The above interesting results of irradiating birds fall into line with results previously obtained with mammals. The beneficial influence of sunlight on the health and rate of growth of young pigs was noted at the Rowett Institute in 1920, where pigs confined in a badly lit and badly ventilated sty failed to grow. Hess and his co-workers in America found that sunlight or artificially produced ultra-violet rays prevented or cured rickets, a disease of metabolism. Orr, Magee and Henderson (*Proc. Physiol. Soc.*, 5/7/24) found that, in growing pigs on a diet badly balanced with regard to its mineral content, irradiation definitely increased the absorption and retention in the body of calcium and phosphorus.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE and FEEDING STUFFS in September, October and November 1925.

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND.

(*Compiled from Reports received from the Board's Market Reporters.*)

Description.	September.			October.			November.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
FAT STOCK :—									
CATTLE—	per cwt. l.w. *s. d.*	per cwt. l.w. *s. d.*	per cwt. l.w. *s. d.*	per cwt. l.w. *s. d.*	per cwt. l.w. *s. d.*	per cwt. l.w. *s. d.*	per cwt. l.w. *s. d.*	per cwt. l.w. *s. d.*	per cwt. l.w. *s. d.*
Aberdeen-Angus ...	70 0	62 10	47 3	70 6	62 11	45 10	71 2	64 0	45 4
Cross-bred (Shorthorn)	64 11	57 10	42 2	65 4	57 5	41 2	66 3	58 11	46 2
Galloway	61 0	56 11	..	62 10	57 5	..	64 3	57 11	.
Ayrshire	59 5	52 10	38 4	59 6	51 6	37 4	61 6	50 3	36 3
Blue Grey	62 0		...	63 6		.	64 0	59 0	...
Highland	62 3	59 0	..	66 3		...	66 7	60 5	...
	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*
VEAL CALVES	17	12	8	18	12¾	8¾	19	13½	10
SHEEP—	under 60 lb. per lb. *d.*	60 lb and upw'ds per lb. *d.*	Ewes per lb. *d.*	under 60 lb. per lb. *d.*	60 lb. and upw'ds per lb. *d.*	Ewes per lb. *d.*	under 60 lb. per lb. *d*	60 lb. and upw'ds. per lb. *d.*	Ewes per lb. *d.*
Cheviot	15¼	14¼	11¾	14¼	13¼	10¾	14½	13¼	11
Half-bred .. .	15	13¾	10¾	14¾	13¼	10¼	14¾	13½	10
Blackface	14½	12¾	11	14	12½	10¼	14¼	12¾	10¼
Greyface	15½	13¾	8¾	14¾	13	8¾	14¼	13	9
Down Cross	15	14	...	14½	13½	...	14¼	13½	...
PIGS—	per stone. *s. d.*	per stone. *s. d.*	per stone. *s. d.*	per stone. *s. d*	per stone. *s. d.*	per stone. *s. d.*	per stone. *s. d.*	per stone. *s. d*	per stone. *s. d.*
Bacon Pigs	13 1	11 10	...	13 9	12 7	...	14 2	12 11	.
Porkers	13 5	12 4	..	14 1	13 0	...	14 4	13 3	..

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND—*continued*.

Description.	September.			October.			November.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
STORE STOCK —									
Store Cattle—	Per head	Per head	Per head	Per head	Per head	Per head.	Per head	Per head	Per head
Aberdeen Angus	£ s	£ s	£ s	£ s	£ s	£ s	£ s	£ s	£ s
Yearlings	21 2	17 15	14 5	20 7	16 8	13 4	19 10	16 8	12 6
Two year olds	26 12	21 9	18 0	26 13	21 15	17 11	26 0	21 0	18 2
Cross bred (Shorthorn)									
Yearlings	18 5	15 2	13 5	18 12	15 7	12 8	18 5	15 4	12 9
Two-year olds	25 11	20 0	16 13	25 1	20 4	16 18	24 2	19 9	16 0
Galloway.									
Yearlings	18 5	13 10		17 12	11 10		16 9		
Two year olds	25 5	20 0		25 2	19 0		25 0		
Ayrshire									
Yearlings	10 10	9 15		10 11	8 10		9 5		
Two year olds				19 17	13 0	12 0			
Blue Grey.									
Yearlings	14 10								
Two-year-olds	24 5			23 0					
Highland									
Yearlings	12 9	9 18	7 10	14 0	11 11	9 12	12 8	10 19	8 10
Two-year-olds	15 10	12 18	10 17	16 16	13 18	11 11	17 11	14 12	12 9
Three-year-olds	28 0	22 0	18 5	23 0	19 15	16 13	19 13	17 16	15 15
Dairy Cows—									
Ayrshire									
In Milk	32 1	24 9	14 5	33 7	25 1	13 18	32 18	25 19	13 6
Calvers	32 16	24 11	15 6	31 17	24 11	15 2	32 6	25 2	14 17
Shorthorn Crosses									
In Milk	38 8	28 6	20 8	38 12	30 13	20 5	38 19	30 5	19 18
Calvers	37 12	27 17	18 5	38 3	28 12	18 11	36 16	27 7	17 7
Store Sheep—	s d	s d	s d	s d	s d	s d	s d	s d	s d
Cheviot Hoggs	115 0	75 3	57 6	100 0	61 10	49 6			33 11
Half bred Hoggs	106 0	86 6	74 3	85 3	78 6	48 3			
Blackface Hoggs	61 4	51 6	39 3	50 3	42 1	38 8		37 5	31 1
Greyface Hoggs ..	94 0	64 7	55 9	71 0	62 2	49 3			49 0
Down Cross Hoggs									
Store Pigs—									
(6 to 10 weeks old)	41 1	27 5		43 1	28 9		43 7	28 10	

Average Prices of Dead Meat at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Quality.	September. Dundee.	September. Edinburgh.	September. Glasgow.	October. Dundee.	October. Edinburgh.	October. Glasgow.	November. Dundee.	November. Edinburgh.	November. Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb d.	per lb d.	per lb. d.	per lb. d.	per lb. d.
Beef :—										
Home-fed—										
Bullock or Heifer ...	1	10	10¼	11½	9⅞	9⅞	11⅜	9¾	9¾	11½
	2	9¾	...	10⅛	9⅝	...	10⅛	9½	8½	10
Bull	1	8⅛	8½	8¼	8⅜	8⅜	8½	8¼	7⅝	8¼
	2	7⅞	8	7½	8	8	7⅛	8	...	7½
Cow	1	7⅛	6½	7½	7	6⅝	7⅛	7	6¼	7⅛
	2	6⅜	6	5¾	6½	..	5⅝	6½	...	5½
Irish—										
Bullock or Heifer ..	1	...	...	9¾	...	...	9¼	...	...	9¼
	2	...	...	8½	...	...	8⅛	..	.	8¼
Bull	1	..	..	7¼	...	...	7⅛	..	...	7¼
	2	...	..	6¾	...	...	6½	...	...	6⅝
United States & Canadian—										
Killed at Birkenhead	1	...	...	...	...	...	8½	...	...	8¼
	2	...	...	...	...	...	8	.	...	...
,, Glasgow ...	1	...	...	9¾	...	...	9¼	...	...	9
	2	...	...	8½	...	...	8¼	...	...	8⅛
Argentine Frozen—										
Hind Quarters ...	1	.	6½	..	...	6½	...	...	5⅞	...
	2	...	6¼	...	...	6	...	..	5½	...
Fore ,, ...	1	...	5	...	...	5⅜	...	...	5	...
	2	...	4⅝	...	...	5¼	...	...	...	...
Argentine Chilled—										
Hind Quarters ..	1	...	8⅛	7¼	...	7⅞	7¾	...	6⅞	6⅝
	2	..	7⅝	6⅞	...	7½	7½	...	6½	6⅝
Fore ,, ...	1	...	5¼	5	...	5½	5½	...	5⅛	4⅞
	2	...	5	4⅝	...	5	5⅛	. .	4¾	4
New Zealand Frozen—										
Hind Quarters ..	1	...	...	6½	...	..	6⅛	...	...	5⅛
	2	..	...	...	...	...	. .	...	...	...
Fore ,, ...	1	...	...	3¾	...	...	4⅝	...	...	4⅝
	2	.	...	...	...	...	...	...	...	...
Mutton :—										
Hoggs, Blackface ...	under 60 lb.	15¼	12½	12¾	14½	11⅞	11⅞	13	11	11⅝
	60 lb. & over	14⅜	...	11⅞	13½	.	11⅝	12	9	11⅛
,, Cross	under 60 lb.	15¼	12½	12¾	14½	11⅞	11¾	13	11	11½
	60 lb. & over	14⅜	...	11⅜	13½	...	11⅛	12	9	11⅛
Ewes, Cheviot	1	11⅜	...	9¼	10½	.	8⅜	9	7⅝	8¼
	2	10½	...	8¼	9½	...	7⅛	8	...	7⅝
,, Blackface ...	1	11⅜	...	8¾	10½	...	8⅛	9	7⅝	8¼
	2	10½	...	7½	9½	...	6⅝	8	...	6⅝
,, Cross	1	8⅝	8⅞	8	8½	8⅜	7¼	7	7⅜	7⅛
	2	8	...	7¼	7½	...	7	6	...	....
Argentine Frozen ...	1	...	...	6½	...	...	6¾	...	...	6¾
	2	...	...	5⅝	...	...	...	...	...	...
Australian ,, ...	1	...	7⅛	...	...	7½	...	...	6⅞	...
	2	...	7	...	...	7¼	...	...	6½	...
New Zealand ,, ...	1	...	...	...	...	...	...	...	...	7
	2	...	..	...	...	...	...	...	. .	6⅞
Lamb :—										
Home-fed	1	15⅝	13⅝	13¼	...	12¾	12	...	11⅝	11⅝
	2	...	...	10¼	...	...	9⅞	...	9	10⅛
New Zealand Frozen ...	1	...	12	11½	...	11⅝	11⅜	...	11¼	10
	2	...	11⅞	10	...	...	9¾	...	...	...
Australian Frozen ...	1	...	...	...	...	...	..	...	...	..
	2	...	...	...	..	...	...	...	...	...
Argentine ,, ...	1	...	...	...	...	...	...	...	...	...
	2	...	...	...	...	...	...	...	...	...

AVERAGE PRICES OF PROVISIONS AT GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Description.		Quality.	September s. d.	October s. d.	November s. d.
BUTTER					
Irish Creamery	per cwt	1	204 2	221 6	213 0
		2	199 2	213 0	207 8
,, (Unsalted) ..	,,	1	209 10	229 6	219 0
		2	192 0	...	.
Argentine (Unsalted)	,,	1	.		192 0
Australian	,,	1	210 10	224 6	213 6
Canadian	,,	1	202 2	220 6	208 0
Danish	,,	1	228 7	235 3	222 9
,, (Unsalted) ...	,,	1	237 5	240 9	228 9
Friesland (Unsalted)...	,,	1	226 2	231 3	223 0
New Zealand	,,	1	214 7	230 0	219 3
,, (Unsalted)	,,	1	217 6	240 0	236 0
Russian ...	,,	1	184 0	187 0	183 4
CHEESE					
Cheddar	,,	1	121 7	130 3	131 0
		2	115 9	124 0	124 0
Cheddar Loaf	,,	1	147 0	154 0	154 0
Dunlop	,,	1	119 5	122 0	124 0
		2	109 3	110 0	111 4
Canadian	,,	1	114 10	122 9	121 0
New Zealand (Coloured)	,,	1	116 5	124 3	123 6
,, (White)	,,	1	116 5	124 3	125 0
BACON					
Ayrshire (Rolled) ...	,,	1	166 0	165 6	161 8
Irish (Green)	,,	1	156 5	151 0	145 3
,, (Dried or Smoked)	,,	1	167 2	160 9	154 9
,, (Long Clear) ..	,,	1	165 0	165 9	163 3
Wiltshire (Green) ...	,,	1	154 5	150 6	143 6
,, (Dried or Smoked)	,,	1	166 2	160 0	152 8
American, Long Clear Middles (Green)	,,	1	133 7	134 6	128 0
,, Short Clear Backs	,,	1	120 0	121 6	120 3
,, Sides	,,	1	127 2	118 9	112 0
,, Cumberland Cut	,,	1	128 4	..	...
Canadian, Sides ...	,,	1	134 2	123 9	116 6
,, Cumberland Cut	,,	1	. .	. .	. .
Danish, Sides	,,	1	139 7	137 6	130 6

Description.		Quality.	September. s. d.	October. s. d.	November. s. d.
HAMS					
Irish (Smoked)	per cwt	1	232 2	222 0	192 0
		2	223 2	209 6	180 6
American, Long Cut (Green)	,,	1	133 10	134 0	135 6
American, Short Cut	,,	1	127 0	126 6	126 3
Canadian, Long Cut	,,	1	125 7	134 0	133 0
EGGS					
Country .	per doz	1	2 5	2 11	3 9
		2	2 3	2 9	3 7
Irish ..	per 120	1	19 8	25 9	34 11
		2	18 2	24 6	33 2
,, (Stored)	,,	1	17 8	19 0	17 11
		2	...	18 1	17 3
,, (Duck) ...	,,	1	17 10	22 3	25 0
		2	...	20 8	...
Australian	,,	1	...	24 6	25 9
		2	...	23 6	25 0
Belgian ..	,,	1	19 1	...	...
,, (Pickled)	,,	1	. .	16 6	16 6
Canadian .	,,	1	. .	21 0	22 0
		2	. .	20 0	21 0
,, (Stored)	,,	1	.	18 10	20 11
		2	...	18 6	19 0
Chinese ...	,,	1	14 0	...	15 0
		2	13 0	...	14 3
Danish	,,	1	21 8	25 9	34 9
		2	20 6	24 2	32 8
Dutch	,,	1	19 4	22 5	29 6
		2	18 6	...	28 6
,, (Duck)	,,	1	...	17 11	17 8
Galician ..	,,	1	14 6	14 11	16 6
Polish .. .	,,	1	13 6	14 4	16 0
		2	12 9	13 8	15 4
Roumanian ...	,,	1	...	15 9	17 10
Russian ...	,,	1	14 4	15 5	17 0
		2	13 8	14 11	16 5

AVERAGE PRICES OF POTATOES AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Market.	Quality.	First Earlies.	Second Earlies.	Late Varieties. Red Soils. Langworthy and Golden Wonder.	Late Varieties. Red Soils. Other.	Late Varieties. Other Soils. Langworthy and Golden Wonder.	Late Varieties. Other Soils. Other.
		per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
SEPTEMBER.							
Dundee ...	1	...	4 18 0	...	...	...	4 12 0
	2	...	...	...	...	...	...
Edinburgh ...	1	...	5 13 0	...	...	...	...
	2	...	...	...	...	...	...
Glasgow ...	1	...	5 8 0	...	...	...	5 15 0
	2	...	...	...	...	...	...
OCTOBER.							
Dundee ...	1	...	3 10 0	...	...	...	4 0 0
	2	...	...	...	...	...	...
Edinburgh ...	1	...	4 19 0	...	...	...	4 15 0
	2	...	...	...	...	...	...
Glasgow ...	1	...	4 17 0	...	...	7 4 0	4 17 0
	2	...	...	...	...	...	...
NOVEMBER.							
Dundee ...	1	...	...	...	...	...	4 0 0
	2	...	...	...	...	...	...
Edinburgh ...	1	...	4 10 0	...	...	...	4 11 0
	2	...	...	...	...	...	...
Glasgow ...	1	...	...	...	6 0 0	6 13 0	4 10 0*
	1	...	...	...	...	...	4 3 0†

* Kerr's Pink. † Arran Chief.

AVERAGE PRICES OF ROOTS, HAY, STRAW, AND MOSS LITTER, AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

MARKET.	Quality.	Roots			Hay.		Straw.			Moss Litter.
		Carrots.	Yellow Turnips.	Swedes.	Rye Grass and Clover.	Timothy.	Wheat.	Barley.	Oat.	
		per ton s. d.	per ton s. d.	per ton s. d.	per ton s. d.	per ton s. d.	per ton s. d.	per ton. s. d.	per ton s. d.	per ton. s. d.
SEPTEMBER.										
‡ Dundee ...	1	...	...	...	108 0	...	69 0	...	69 0	52 0*
	1	...	...	..	118 0†	...	...	...	...	...
‡ Edinburgh	1	...	...	...	109 0	...	64 0	...	59 0	44 0
	1	...	...	...	120 0†	...	...	...	...	...
‖ Glasgow ...	1	...	...	...	92 0**	97 0	65 0	...	60 0	37 6
	1	...	...	..	75 0§	...	...	...	...	...
OCTOBER										
‡ Dundee ...	1	...	...	...	111 11	...	70 0	...	70 0	52 0*
	1	...	..	.	120 0†	...	90 0†	...	90 0†	...
‡ Edinburgh	1	...	..	..	112 6	...	65 0	...	62 6	44 0
	1	...	.	...	120 0†	...	...	...	...	...
‖ Glasgow ...	1	...	..	...	95 0**	100 0	66 3	...	65 0	37 6
	1	...		...	75 0§	...	...	...	..	...
NOVEMBER.										
‡ Dundee ...	1	...	22 6	...	114 5	...	70 0	70 0	78 9	52 0*
	1	...	...	.	125 0†	...	...	...	...	...
‡ Edinburgh	1	...	...	...	116 3	...	70 8	...	70 8	44 0
	1	...	...	...	123 2†	...	...	...	...	...
‖ Glasgow ...	1	...	...	...	96 3**	101 3	73 9	...	73 9	37 6
	1	...	...	...	75 0§	...	...	...	...	...

* At Quay. ** Old Crop. † Baled and delivered. § New Crop.

‡ Quotations for Hay and Straw, delivered loose in town, except where otherwise indicated.

‖ ,, baled Hay and Straw, f.o.r.

AVERAGE PRICES OF FEEDING STUFFS AT GLASGOW AND LEITH
(Compiled from Reports received from the Board's Market Reporters.)

Description.	September.		October.		November.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	13 9 0	12 15 0	13 1 3	12 5 0	12 11 3	12 1 3
Foreign	13 5 10	...	12 16 3	...	12 1 3	..
Decorticated Cotton Cake	12 10 8	...	12 10 0	...	...	...
Undecorticated Cotton Cake—						
Bombay (Home-manufactured)...	7 18 0	7 5 0	7 7 6	6 18 9	7 1 3	6 12 6
Egyptian (Home-manufactured)...	8 17 0	...	8 12 6	...	8 2 6	...
Palmnut Kernel Cake	.	..	9 8 4	...	9 5 0	...
Coconut Cake ...	...	...	11 10 0	...	11 9 2	...
Groundnut Cake— Undecorticated	*9 19 6	...	*9 11 3	...	*9 2 6	...
	**10 9 6	...	**10 0 8	...	**9 12 6	**9 5 0
Maize Germ Cake—						
Home	12 2 0	..	11 15 0	...	11 0 0	...
Foreign	11 16 0	...	11 7 6	...	11 5 0	...
Maize Germ Cake Meal	12 2 6	...	11 17 6	...	11 10 0	...
Bean Meal	12 3 6	12 5 0	12 0 0	12 1 3	12 0 10	12 0 0
Maize Meal—						
Home Manufactured	12 5 6	..	11 2 6	...	10 18 4	...
South African Yellow	11 0 6	11 0 0	10 0 0	9 12 6	9 11 8	9 10 0
Rice Meal	8 11 3	...	8 3 9	...	7 8 4	...
Locust Bean Meal...	11 16 3	10 0 0	10 7 6	9 10 0	10 0 0	9 0 0
Locust Beans (Kibbled and Stoned)	10 0 0	9 7 6	9 15 0	8 13 2	...	8 5 0
Maize Gluten Feed (Paisley) ...	10 1 6	...	9 10 0	...	9 10 0	...
Maize	11 4 6	10 16 0	9 18 2	9 5 0	9 11 3	9 0 0
Oats, Canadian—						
,, (No. 2 Feeds)	9 10 0	9 15 0	9 16 8	9 15 0	...	...
,, (No. 2 Western)	11 13 9	12 0 0	...	12 0 0	...	...
,, Plate	9 18 6	...	9 10 0	..	...	..
,, Home, Old ...	12 6 0	..	12 6 8	..	...	...
,, ,, New...	10 8 4	10 12 0	10 5 0	9 5 0	9 10 0	8 15 0
Barley (Feeding) ...	11 14 0	10 16 0	†9 4 5	10 0 0	†9 1 3	9 15 0
Barley Bran ...	10 5 0	...	10 0 0	.	9 7 6	...
Malt Culms... ...	7 6 0	..	7 10 0	...	7 3 9	...
Distillery Mixed Grains—Dried	9 0 0	9 10 0	9 0 0	9 10 0	9 0 0	9 10 0
Brewers' Grains—Dried	8 18 4	8 1 0	..	8 5 0	8 15 0	8 5 0
Distillery Malt Grains—Dried .	8 18 9	..	8 13 9	...	8 12 6	...
Wheat—						
Middlings (Fine Thirds or Parings)	10 7 0	9 0 0	9 15 8	8 12 6	9 5 0	8 7 6
Sharps (Common Thirds) ..	8 6 0	8 4 0	7 12 6	7 13 9	7 5 0	7 10 0
Bran (Medium) ...	7 18 6	7 19 0	7 10 8	7 7 6	7 9 5	7 7 6
,, (Broad) ...	8 6 6	8 12 0	8 5 0	8 7 6	7 17 6	8 10 0
Feeding Treacle ..	8 0 0	8 4 0	8 0 0	8 0 0	8 0 0	8 0 0
Crushed Linseed ...	27 14 0	...	27 10 0	...	27 10 0	...
Fish Meal	20 16 0	18 15 0	20 12 6	18 15 0	20 10 0	18 15 0
Beans—						
China	11 5 6	...	11 4 2	...	11 0 0	...
English	12 12 6	...	11 11 8	...	11 7 6	...
Sicilian	11 4 6	...	10 16 3	...	10 13 2	...

* 37 per cent. Oil and Albuminoids. ** 40 per cent Oil and Albuminoids.
† Foreign Barley.

STATEMENT SHOWING THE ACREAGE UNDER EACH VARIETY OF POTATOES IN SCOTLAND IN 1925.

Variety.	Acres.
A. FIRST EARLIES.	
1. America *	24
2. Arran Rose *	35
3. Dargill Early *	120
4. Di Vernon *	45
5. Immune Ashleaf * ...	139
6. Snowdrop (including Witch Hill) * ...	110
7. Beauty of Hebron (including Puritan) ...	135
8. Duke of York (including Midlothian Early and Victory)	1,423
9. Eclipse (including Sir John Llewelyn) ...	1,822
10. Epicure	9,372
11. May Queen	232
12. Myatt's Ashleaf Kidney	21
13. Ninetyfold	173
14. Sharpe's Express ...	2,131
15. Sharpe's Victor	71
16. Other First Earlies not specified above ...	102
Total First Earlies ...	15,955
B. SECOND EARLIES.	
17. Ally *	754
18. Arran Comrade * ...	627
19. Catriona *	49
20. Edzell Blue *	329
21. Great Scot *	9,167
22. Katie Glover *	118
23. King George V. * ...	486
24. K. of K. *	20
25. British Queen (including Pioneer, Macpherson, Maid of Auchterarder, Scottish Standard, English Beauty, etc.)	5,774
26. Royal Kidney (including Queen Mary)	209
27. Other Second Earlies not specified above ...	159
Total Second Earlies	17,692
C. MAINCROPS.	
28. Sutton's Abundance (including Admiral, Balmuir, Bloomfield, Culdees Castle, Kerr's New White, Laing's Prolific, Lomond, Twentieth Century, Osborne Seedling, Just in Time, etc.) *	1,562
29. Arran Victory * ...	606
30. Bishop *	70
31. Champion *	1,406
32. Crusader *	651
33. Early Market *	160
34. Golden Wonder (including Peacemaker) * ..	10,560
35. Irish Queen *	290
36. Kerr's Pink *	30,623
37. Langworthy (including Maincrop and What's Wanted) *	829
38. Lochar *	141
39. Majestic *	2,977
40. Rhoderick Dhu * ...	838
41. Templar *	58
42. Tinwald Perfection * ..	1,332
43. White City (including Carnegie) *	58
44. Arran Chief	16,175
45. Evergood	207
46. Field-Marshal	2,668
47. General	103
48. King Edward VII. (including Red King) ..	15,434
49. Northern Star (including Ajax, Allies and Aeroplanes)	144
50. President (including Iron Duke and Scottish Farmer)	229
51. Up to-Date (including Dalhousie, Factor, Glamis Beauty, Scottish Triumph, Stephen, Table Talk, Laing's Imperial, etc.	2,473
52. Other Maincrops not specified above ...	937
Total Maincrops ...	90,531

TOTAL AREA RETURNED ... 124,178 ACRES.

NOTES.—(1) In the county of Inverness the districts of Skye, Harris, North and South Uist were excluded. In the county of Ross the Western and South-Western districts and the district of Lewis were excluded.

(2) Varieties marked thus * are immune from Wart Disease.

ABSTRACT OF AGRICULTURAL RETURNS FOR SCOTLAND, 1925.

Collected 4th June 1925 (and comparison with 1924).

CROPS.

Distribution	1925.	1924	Increase		Decrease	
	Acres	*Acres*	*Acres*	*Per Cent*	*Acres*	*Per Cent*
Total Area (excluding Water)	19,069,683	19,069,683				..
Total Acreage under all Crops and Grass (a)	4,705,197	4,715,290			10,093	0 21
Arable Land	3,229,359	3,278,116			48,757	1 34
Permanent Grass (a) — For Hay	156,244	154,765	1,479	0 96		
Permanent Grass (a) — Not for Hay	1,319,594	1,287,409	32,185	2 50		
Permanent Grass (a) — Total	1,475,838	1,442,174	3,664	2 33		
Wheat	48,617	49,449			832	1 68
Barley (including Bere)	152,921	151,588	1,333	0 88		
Oats	925,995	905,535			29,540	3 09
Mixed Grain	1,971	1,333	638	47 86		
Rye	5,360	6,635			1,275	19 22
Beans (to be harvested as Corn)	3,409	3 732			323	8 65
Peas	457	499			42	8 42
Potatoes	142,155	138 281	3 874	2 80		
Turnips and Swedes	395,940	405,693			9,753	2 40
Mangolds	1,117	1,316			199	15 12
Cabbage	4,160	4,139	21	0 51		
Rape	12 607	11,843	764	6 45		
Vetches or Tares for Seed	196	269			73	27 14
Vetches, Tares, Beans, Peas, Mashlum etc, for Fodder	10,653	10 650	3	0 03		..
Sugar Beet	1,493	196	1,297	661 73		
Carrots	275	391			116	29 67
Onions	139	161			22	13 66
Flax	753	120	627	407 62		
Small Fruit	7,189	6,969	220	3 16	..	
Rye grass and other Rotation Grasses and Clover — For Hay	403,097	415,322			12,225	2 94
Rye grass and other Rotation Grasses and Clover — Not for Hay	1,099,420	1,099,753			333	0 03
Rye grass and other Rotation Grasses and Clover — Total	1,502,517	1,515,075			12,558	0 83
Other Crops	2,372	2,244	128	5 70		
Bare Fallow	9,063	6,992	2,071	29 62		
Orchards (b)	1,163	1,344			181	13 47

LIVE STOCK.

	1925	1924	Increase		Decrease	
	No	*No*	*No*	*Per Cent*	*No*	*Per Cent*
Horses used for Agricultural purposes (including Mares for Breeding)	136,652	137,260			608	0 44
Unbroken Horses (including Stallions) — One year and above	21,885	27,515		..	5,630	20 46
Unbroken Horses (including Stallions) — Under one year	5,814	6,392			578	9 04
Total	164,351	171,167			6,816	3 98
Other Horses	21,082	22,529			1,447	6 42
Total of Horses	185,433	193,696			8,263	4 27
Cows in Milk	348,326	352,256			3,930	1 12
Cows in Calf, but not in Milk	49,798	46,439	3,359	7 23		
Heifers in Calf	52,227	49,693	2,534	5 10		
Bulls being used for Service	17,369	17,579			210	1 19
Other Cattle — Two Years and above	236,072	214,596	21,476	10 01		
,, ,, One Year and under two	276,900	263 440	13,460	5 11		
,, ,, Under one year	224,099	220,394	3,705	1 68		
Total of Cattle	1,204,791	1,164,397	40,394	3 47		
Ewes kept for Breeding	3,055,887	2,992,113	63,774	2 13		
Rams to be used for Service in 1925	86,355	83,876	2,479	2 96		
Other Sheep — One year and above	1,045,707	987,267	58,440	5 92		
,, ,, Under one year	2,930,871	2,822,896	107,975	3 82		
Total of Sheep	7,118,820	6,886,152	232,668	3 38		
Sows kept for Breeding	16,161	24,014			7,853	32 70
Boars being used for Service	1,875	2,721			846	31 09
Other Pigs	136,184	172,101			35,917	20 87
Total of Pigs	154,220	198,836			44,616	22 44

(a) Excluding Mountain and Heath Land used for grazing (9,648,996 acres in 1925)
(b) Any Crop or Grass grown in Orchards is also returned under its proper heading

ACREAGE under WHEAT, BARLEY (including BERE), and OATS in each COUNTY on 4th June 1925, with COMPARISON for 1924.

COUNTIES.	Wheat.		Barley (including Bere).		Oats	
	1925.	1924.	1925.	1924.	1925.	1924
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN ..	18	50	19,753	18,901	183,620	188,328
ARGYLL	...	...	1,211	1,226	15,397	16,007
AYR	858	726	233	166	39,367	41,658
BANFF	...	...	7,770	7,271	46,602	48,067
BERWICK	1,194	1,285	15,637	15,680	28,149	28,758
BUTE	1	3	10	20	4,739	4,823
CAITHNESS ...	...	...	612	545	29,694	29,876
CLACKMANNAN ...	205	228	202	183	2,931	3,267
DUMBARTON ...	465	378	17	12	6,695	7,146
DUMFRIES	44	37	306	307	37,434	38,692
EAST LOTHIAN .	4,228	4,115	15,259	14,923	15,795	16,805
FIFE	10,933	11,812	14,719	14,101	41,804	43,452
FORFAR	9,824	9,985	17,588	17,850	54,322	55,696
INVERNESS ...	...	34	4,540	4,678	29,737	30,514
KINCARDINE ..	899	910	9,542	9,948	29,351	30,014
KINROSS	152	149	166	179	6,664	6,840
KIRKCUDBRIGHT ...	8	8	51	31	22,119	22,982
LANARK	1,830	1,502	77	107	36,497	38,113
MIDLOTHIAN ..	5,060	4,702	4,814	4,830	20,501	21,484
MORAY	380	381	9,645	9,349	24,159	24,721
NAIRN	67	...	2,309	2,293	6,209	6,214
ORKNEY . ..	...	...	3,678	3,589	32,751	33,096
PEEBLES	...	..	93	93	5,870	6,063
PERTH	6,461	7,418	3,860	3,809	67,382	68,957
RENFREW ...	1,490	1,595	7	62	9,503	10,197
ROSS & CROMARTY	599	393	7,522	8,011	31,015	31,502
ROXBURGH ...	352	355	9,225	9,246	24,228	25,092
SELKIRK	...	8	229	238	3,758	3,977
SHETLAND ...	...	...	623	636	6,244	6,446
STIRLING	1,502	1,334	920	874	17,798	18,539
SUTHERLAND .	...	...	291	399	7,431	7,695
WEST LOTHIAN ...	2,035	2,036	1,841	1,820	10,438	11,192
WIGTOWN	12	5	171	202	27,791	29,320
TOTAL ...	48,617	49,449	152,921	151,588	925,995	955,535

ACREAGE under BEANS, POTATOES, and TURNIPS and SWEDES in each COUNTY on 4th June 1925, with COMPARISON for 1924.

COUNTIES.	Beans.*		Potatoes.		Turnips and Swedes.	
	1925.	1924.	1925.	1924.	1925.	1924.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN ...	11	11	7,553	7,329	81,405	81,585
ARGYLL	16	15	2,871	3,015	4,762	5,146
AYR	196	223	8,605	7,860	7,006	7,624
BANFF	31	25	1,744	1,735	19,829	20,032
BERWICK	156	177	2,573	2,597	20,593	21,158
BUTE	10	15	1,088	1,018	1,235	1,340
CAITHNESS ...	...	...	1,225	1,238	11,051	11,329
CLACKMANNAN ..	242	229	401	410	727	812
DUMBARTON ...	11	14	2,276	2,198	1,354	1,458
DUMFRIES ...	4	...	3,296	3,199	14,789	15,507
EAST LOTHIAN .	75	63	8,076	7,678	12,405	12,913
FIFE	248	353	16,981	16,643	21,349	21,786
FORFAR	17	24	17,828	17,608	30,341	30,584
INVERNESS ..	...	...	5,255	5,302	8,998	8,995
KINCARDINE ...	10	24	4,529	4,307	15,088	15,282
KINROSS	...	5	1,233	1,148	2,210	2,383
KIRKCUDBRIGHT	7	4	1,359	1,324	9,335	10,072
LANARK	4	...	5,172	4,878	9,203	9,611
MIDLOTHIAN ...	2	2	6,438	6,225	9,579	9,747
MORAY	23	11	1,585	1,557	13,358	13,683
NAIRN	...	...	261	265	3,777	3,755
ORKNEY	...	...	2,204	2,210	13,329	13,616
PEEBLES	...	1	301	281	2,889	3,038
PERTH	763	793	17,474	17,047	24,046	24,747
RENFREW	61	66	2,967	2,803	1,977	2,083
ROSS & CROMARTY	...	...	7,150	7,149	13,732	13,993
ROXBURGH ...	20	58	1,188	1,158	16,818	17,482
SELKIRK	...	...	147	154	2,152	2,125
SHETLAND ...	...	...	2,042	2,064	991	1,014
STIRLING	1,384	1,470	3,181	2,957	3,572	3,911
SUTHERLAND ...	...	...	1,108	1,168	2,649	2,796
WEST LOTHIAN ...	28	33	2,506	2,340	3,187	3,391
WIGTOWN	90	116	1,538	1,416	12,204	12,695
TOTAL	3,409	3,732	142,155	138,281	395,940	405,693

* To be harvested as corn.

ACREAGE under RYE-GRASS and other ROTATION GRASSES and CLOVER, and under PERMANENT GRASS in each COUNTY on 4th June 1925, with COMPARISON for 1924.

Counties	Rye-grass and other Rotation Grasses and Clover.				Permanent Grass.			
	For Hay		Not for Hay.		For Hay.		Not for Hay.	
	1925	1924	1925	1924	1925.	1924	1925.	1924.
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
ABERDEEN	50,751	52,939	238,720	237,290	553	834	39,708	35,483
ARGYLL	12,170	11,926	15,952	16,027	15,346	15,066	56,026	55,551
AYR	28 210	28,226	50 960	47,952	22,369	22,653	150,687	153,292
BANFF	9,980	10,218	60,824	58,877	194	308	9,501	10,456
BERWICK	10,682	11,399	50,869	49,709	1,894	1,145	55,643	55,435
BUTE	2,442	2,448	5,265	5,162	330	320	9,935	9,933
CAITHNESS	10,097	10,076	26,745	26,781	805	770	25,859	25,700
CLACKMANNAN	1,275	1,420	1,216	1 310	1,036	917	6,635	6,287
DUMBARTON	5,316	5 774	6,368	5,919	2,570	2,491	20,586	20,377
DUMFRIES	19,614	20,432	48 942	48 958	18,424	19,103	99,977	97,742
EAST LOTHIAN	8,276	9,169	16,466	16,909	1,114	1,127	24,482	22,558
FIFE	26,132	27,016	30,159	30,842	3,261	2,781	72,174	69,925
FORFAR	22,055	22,962	63,261	61,717	1,212	1,072	25,739	25,373
INVERNESS	11,293	11,530	22 041	21,728	8 989	8,439	57,337	56,699
KINCARDINE	13,200	13,499	35,255	35,305	172	113	9,108	8,166
KINROSS	2,971	3,197	7 447	8 103	408	607	11,959	10,709
KIRCUDBRIGHT	10,401	10,460	47 421	53,347	12,762	12,593	77,447	70,066
LANARK	31,906	32,298	35,376	37,495	13,613	13,339	104 710	103,122
MIDLOTHIAN	11,857	11,354	15,374	16,081	1,602	1,899	40,621	40,111
MORAY	5,832	6,099	34,446	33,969	277	286	7,400	7,104
NAIRN	1,691	1,710	9,368	9,142	39	48	1,427	1,784
ORKNEY	10,173	8,508	30,166	31,847	698	583	13,878	13,491
PEEBLES	2,309	2,552	11,329	10,608	1,277	1,238	26,049	26,153
PERTH	32,596	34,753	62,171	63,241	11,167	11,085	91,995	87,614
RENFREW	9,120	9,320	6,591	7,165	6,684	7,190	43,840	42,111
ROSS AND CROMARTY	12,504	13,054	35,696	35,022	2,692	2,779	25,642	24,583
ROXBURGH	9,068	9,375	49,960	47,341	6,656	6,775	57,912	59,227
SELKIRK	1,108	1,300	6,832	7,894	2,417	1,952	12,785	12,007
SHETLAND	1,343	1,366	666	677	1,871	1,727	11,264	10,682
STIRLING	10,688	11,528	10,149	10,642	7,719	7,074	52,964	51,979
SUTHERLAND	4,509	4,588	5,799	5,307	1,540	1,555	7,484	7,269
WEST LOTHIAN	6,573	7,108	5,228	4,613	1,160	1 425	22,137	22,133
WIGTOWN	6,955	7,518	52,856	52,773	5,393	5,171	46,650	44,287
TOTAL	403,097	415,322	1,099,420	1,099,758	156,244	154,765	1,319,594	1,287,409

NUMBER of HORSES, CATTLE, SHEEP and PIGS in each COUNTY on 4th June 1925, with COMPARISON for 1924.

COUNTIES	Horses.*		Cattle.		Sheep.		Pigs.	
	1925.	1924.	1925	1924.	1925	1924	1925.	1924.
	No	No	No.	No	No.	No	No.	No
ABERDEEN	24,889	26,028	174,109	164,594	254,795	222,624	15,821	22,276
ARGYLL	5,029	5,375	52,977	53,816	716,098	743,993	4,159	5,986
AYR	8,135	8,835	106,762	109,973	364,838	363,449	11,237	17,506
BANFF	7,254	7,740	43,637	41,584	74,016	64,482	4,111	4,709
BERWICK	4,316	4,415	23,941	20,680	360,261	346,664	4,060	5,611
BUTE	1,112	1,180	8,796	9,189	39,212	40,172	670	653
CAITHNESS	4,707	5,056	19,809	20,001	152,122	149,226	1,415	2,177
CLACKMANNAN	586	678	3,398	3,636	12,832	12,728	995	1,131
DUMBARTON	1,582	1,690	13,256	12,711	66,942	66,620	1,088	1,537
DUMFRIES	6,302	6,875	68,528	66,311	570,973	548,690	9,497	11,803
EAST LOTHIAN	3,279	3,270	15,256	12,247	151,481	134,706	3,931	4,880
FIFE	8,551	8,841	45,398	42,321	125,300	109,875	7,573	10,240
FORFAR	8 498	8,583	48,917	45,843	189,217	176,723	6,334	8,857
INVERNESS	7,593	7,789	46,030	45,290	507,887	506,541	1,895	2,099
KINCARDINE	4,228	4,352	26,539	25,638	61,201	54,484	2,895	4,122
KINROSS	1,056	1 100	6,378	6,161	32,394	30,728	766	848
KIRKCUDBRIGHT	4,470	4,831	58,110	56,033	383,599	367,078	13,103	15,594
LANARK	7,173	7,576	70,798	71,602	238,534	233,549	6,800	9,357
MIDLOTHIAN	3,438	3,540	17,864	17,324	178,989	169,801	14,021	14,983
MORAY	4,229	4,347	24,305	21,846	51,941	48,611	2,951	3,902
NAIRN	1,195	1 241	6,642	6,367	15,561	13 950	600	812
ORKNEY	5,699	5,863	30,441	30,557	34,892	33,026	1,725	1 739
PEEBLES	961	967	7,355	6,769	205,810	201,129	500	624
PERTH	11,240	11,323	67,714	63,677	627,799	594,113	8,208	11,815
RENFREW	2,446	2,596	25,622	25,508	38,714	40,103	2,719	3,628
ROSS AND CROMARTY	6,238	6,370	40,435	38,725	291,246	279,026	3,105	4,253
ROXBURGH	3 558	3,699	24,289	22,180	564,355	549,219	3,576	4,095
SELKIRK	566	579	3,962	3,659	191,497	186,386	525	823
SHETLAND	2,615	2,454	11,450	11,665	146,544	140,763	260	174
STIRLING	4,001	4,305	33,198	31,570	120,685	116,173	2,524	2,932
SUTHERLAND	2,060	2,114	9,766	9,684	203,992	203,166	560	748
WEST LOTHIAN	2,126	2,091	11,754	11,377	20,735	18,875	1,714	2,331
WIGTOWN	5,224	5,464	57,335	55,856	124,328	119,229	14,879	16,651
TOTAL	164,351	171,167	1,204,791	1,164,397	7,118,820	6,886,152	154,220	198,836

* Horses used for agricultural purposes, mares for breeding, and unbroken horses (including Stallions). "Other Horses" on agricultural holdings are not included; the total for these in Scotland is given in the summary table on p. 115.

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1925.

County	District of County	Wheat	Barley (including Bere)	Oats	Beans*	Potatoes	Turnips and Swedes	Rye-grass and other Rotation Grasses & Clover: For Hay	Rye-grass and other Rotation Grasses & Clover: Not for Hay	Permanent Grass: For Hay	Permanent Grass: Not for Hay	Horses†	Cattle	Sheep	Pigs
		Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	No	No	No	No
ABERDEEN	Aberdeen		5,392	17,282		1,805	9,673	7,488	25,497	28	8,614	2,914	20,184	15,304	8,318
	Alford		712	16,519		328	7,872	4,942	22,125	139	5,516	2,230	16,908	41,241	697
	Deer		2,149	42,182	5	2,108	16,518	12,041	47,695	[illegible]	9,460	5,508	38,314	37,276	3,108
	Deeside		1,722	14,781		493	6,973	5,727	18,642	81	5,444	2,180	14,877	49,844	1,256
	Ellon	18	3,012	26,794		941	12,268	7,636	36,209	35	4,739	3,258	25,038	33,909	1,992
	Garioch		3,237	23,004		676	10,738	5,683	31,454	85	4,403	3,292	23,266	18,010	1,923
	Huntly		955	15,561	1	365	6,294	2,586	22,602	6	4,703	2,066	12,381	40,267	1,214
	Turriff		2,574	27,767	2	834	11,069	4,698	34,496	98	1,829	3,441	23,241	18,854	2,318
ARGYLL	Ardnamurchan			414		229	35	616	177	1,126	1,855	158	2,655	59,479	96
	Cowal		4	1,247		249	413	1,031	421	1,579	6,218	340	4,141	138,333	170
	Islay			3,751		499	1,097	3,019	3,024	1,456	17,536	1,039	9,264	65,973	612
	Kintyre		556	4,579	16	405	2,058	1,642	8,901	1,159	12,224	1,290	13,630	122,082	2,171
	Lorn		18	1,975		624	528	2,490	907	4,891	5,594	762	8,756	168,990	489
	Mid Argyll		5	1,413		342	424	1,769	1,472	3,327	6,979	558	6,924	98,727	317
	Mull		624	2,015		525	207	1,603	650	2,308	5,590	882	7,607	67,514	304
AYR	Ayr	135	34	10,258	74	1,757	1,727	7,571	15,757	6,602	39,090	1,981	28,634	107,623	3,510
	Carrick	15	174	9,518	74	3,594	2,827	5,119	13,868	4,104	33,001	2,079	22,482	185,256	3,397
	Kilmarnock	384	11	9,997	24	1,023	1,221	5,650	12,379	6,151	40,785	2,074	30,129	31,357	3,247
	Northern	324	14	9,594	24	2,251	1,231	6,970	9,016	5,512	37,811	2,001	25,517	40,602	1,083
BANFF	Banff		6,725	25,857	31	1,241	11,[illegible]	5,543	35,089	68	1,719	4,159	26,957	21,387	2,995
	Keith		1,045	20,745		[illegible]	7,934	4,437	25,735	126	7,782	3,065	16,650	52,629	1,119
BERWICK	East	438	5,909	8,635	96	1,295	6,729	3,639	16,072	398	16,826	1,447	7,565	94,630	1,636
	Middle	646	7,744	9,645	50	861	7,959	4,921	14,901	749	20,168	1,662	9,725	123,419	1,689
	West	110	1,984	9,866	10	417	5,875	2,122	19,896	747	19,654	1,207	6,651	142,212	735
BUTE	Arran		5	2,230	10	632	416	1,303	2,290	187	4,856	576	4,245	30,326	296
	Bute and Cumbrae	1	5	2,503		456	819	1,239	2,975	143	5,079	536	4,551	8,886	375
CAITHNESS (not divided)			612	29,694		1,225	11,051	10,097	26,745	805	25,869	4,707	19,809	152,122	1,415
CLACKMANNAN (not divided)		205	202	2,931	242	401	727	1,275	1,216	1,056	6,635	586	3,398	12,852	995
DUMBARTON	Eastern	378	1	3,494		1,146	615	2,891	2,954	1,063	9,100	839	6,025	10,762	712
	Western	87	16	3,201	11	1,130	739	2,425	3,414	1,307	11,486	748	7,231	56,190	376
DUMFRIES	Annan		138	12,220	4	1,058	4,828	5,701	13,901	2,680	16,551	1,876	15,415	50,784	1,861
	Dumfries	41	91	9,162		1,043	3,371	4,021	12,137	2,018	15,612	1,818	13,863	54,331	2,999
	Langholm			2,221		180	894	1,405	2,416	8,275	8,344	445	5,076	123,865	378
	Lockerbie		42	8,394		609	3,478	4,591	11,595	5,691	27,111	1,516	18,065	150,342	1,425
	Thornhill	3	35	6,537		426	2,218	3,896	8,393	4,760	32,359	1,147	16,110	191,651	2,884

* To be harvested as corn.

† See Note on p. 119.

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1925.

County	District of County	Wheat.	Barley (including Bere).	Oats.	* Beans.	Potatoes.	Turnips and Swedes.	Rye-grass and other Rotation Grasses & Clover. For Hay.	Rye-grass and other Rotation Grasses & Clover. Not for Hay.	Permanent Grass. For Hay.	Permanent Grass. Not for Hay.	† Horses	Cattle.	Sheep.	Pigs.
		Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	No.	No.	No.	No.
EAST LOTHIAN	Eastern	1,278	6,030	4,950	35	3,441	4,699	2,670	6,504	690	9,156	1,225	5,229	73,484	1,122
	Western	2,950	9,229	10,845	40	4,635	7,706	5,606	9,962	424	15,326	2,054	10,027	77,997	2,809
FIFE	Cupar	3,676	4,792	13,774	38	6,126	7,502	7,082	14,038	426	15,667	3,507	12,840	51,412	1,854
	Dunfermline	1,032	810	7,501	110	1,761	2,553	4,636	2,799	1,172	22,687	1,463	8,928	24,350	1,768
	Kirkcaldy	2,398	2,632	9,314		3,614	4,265	6,672	5,357	744	15,468	2,018	10,414	20,911	2,073
	St. Andrews	3,827	6,485	11,216	100	5,480	7,029	7,742	7,965	919	18,352	2,558	13,216	28,627	1,878
FORFAR	Arbroath	2,757	4,907	9,137	1	4,359	6,242	4,520	10,859	142	3,551	1,747	10,117	10.550	971
	Brechin	2,108	5,951	17,547	7	4,136	9,678	6,787	20,507	272	6,717	2,491	14,179	70,958	1,718
	Dundee	2,749	2,623	9.907	9	4,418	5,792	4,484	10,525	368	3,563	1,702	9,550	19,850	2,052
	Forfar	2,216	4,107	17,731	..	4,929	8,629	6,314	21,370	430	11,608	2,558	15,071	88,389	1,593
INVERNESS	Inverness		1,875	7,128	.	421	4,226	2,835	10 697	179	4,490	1,438	6,692	43,316	875
	Aird		179	5,749		492	2,527	2,784	5,738	611	4,633	1,067	6,012	44,924	671
	Badenoch	..	55	3,807		177	1,617	2,194	4,554	1,173	9,261	705	4,670	96,528	198
	Lochaber		3	1,022		442	187	1,322	329	2,299	8,127	394	4,537	143,506	140
	Skye		2	5,520	.	1,373	330	1,886	601	3,135	5,439	1,082	9,826	124,997	8
	Harris, N, & S. Uist		2,423	6,511	.	2,350	111	273	125	1,592	30,378	2,957	14,293	54,526	3
KINCARDINE	Laurencekirk	273	1,989	9,152	1	1,509	4,124	3,218	10,065	42	1,868	1,053	6,637	23,957	835
	Lower Deeside		1,130	5,352	..	774	1,735	2,022	3,705		479	561	3,227	731	579
	St Cyrus	579	2,089	5,691	6	1,095	2,974	2,605	5,670	44	2,302	821	3,987	12,688	384
	Stonehaven	47	2,895	7,629	3	875	4,134	3,696	9,737	84	3,291	1,130	8,517	15,939	738
	Upper Deeside		1,439	3,527		276	2,121	1,664	6,078	2	1,173	663	4,191	7,386	359
KINROSS (not divided)		152	166	6,664	..	1,233	2,210	2,971	7,447	408	11,959	1,056	6,378	32,394	766
KIRKCUDBRIGHT	Eastern	.	11	9,293		905	3,748	4,394	14,678	3,473	26,670	1,645	20,040	71,824	4,579
	Northern			1,702	.	119	746	856	4,605	2,765	9,844	472	5,679	141,120	809
	Southern	7	16	9,249		256	4,069	4,136	25,847	4,725	30,591	1,942	26,905	84,456	7,228
	Western	1	24	1,875	7	79	772	1,015	2,791	1,799	10,833	411	5,486	86,699	492
LANARK	Lower Ward	775	15	3,728		1,299	558	3,265	1,672	2,386	6,563	790	4,962	1,892	3,017
	Middle Ward	1,025	56	16,361	.	2,027	3,151	17,129	11,734	6,749	51,487	3,505	35,827	31,134	2,348
	Upper Ward	30	6	16,408	4	1,346	5,494	11,512	21,970	4,478	46,690	2,878	30,009	205,508	1.440
MIDLOTHIAN	Calder	1,407	682	5,886	.	1,727	1,782	3,578	2,237	613	13,356	972	5,577	36,682	2,728
	Gala-Water	208	1,405	5.547	1	390	3,589	2,327	9,482	245	14,630	726	3,514	97,363	566
	Lasswade *	1,167	1,809	5,282	1	1,863	2,699	3,210	3.354	641	8,722	944	4,305	36.631	1,661
	Suburban	2,278	918	3,786	..	2,458	1,509	2,742	301	103	3,916	796	4,168	8,313	9,066
MORAY (not divided)		389	9,645	24,159	23	1,585	13,358	5,832	34,446	277	7,400	4,229	24,305	51,941	2,951
NAIRN (not divided)		67	2,809	6,209	..	261	3,777	1,691	9,368	39	1,427	1,195	6.642	15,561	600

* To be harvested as corn.

† See Note on p. 119.

AGREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1925.

County and District of County		Wheat	Barley (including Bere)	Oats	* Beans	Potatoes.	Turnips and Swedes	Rye-grass and other Rotation Grasses & Clover: For Hay	Rye-grass and other Rotation Grasses & Clover: Not for Hay.	Permanent Grass: For Hay	Permanent Grass: Not for Hay.	† Horses	Cattle	Sheep.	Pigs.
		Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	No	No	No	No
ORKNEY	Mainland		1 135	18 166		1,163	6 810	5,910	16,466	276	7,378	3,136	16,070	14,686	802
	North Isles		2,208	9 786		730	4,737	2 839	10,039	352	5 251	1 830	10,385	15,009	720
	S Ronaldshay & Walls		355	4 799		311	1,782	1,424	3 661	70	1 249	733	3,986	5,197	303
PEEBLES (not divided)			93	5 870		301	2,589	2,309	11,329	1 277	26,049	961	7,355	205,810	500
PERTH	Blairgowrie	2,046	1,782	15 544	5	5 244	6,357	6,683	16,371	337	13,022	2,320	13,588	60,681	2,373
	Central	649	130	14,665	1	3 394	4 691	6,936	13,331	1,352	19,433	2,321	13,131	125,248	1,500
	Highland		70	6 451		519	2,519	4,455	6 331	2 445	14,493	1,283	9,044	195,197	1,114
	Perth	3,482	1,710	21 329	258	6 379	8 404	9,258	18,013	1 851	26,589	3,309	19,099	69,299	2 389
	Western	284	163	9 893	496	1,645	2,075	5 204	8,125	5,182	18,408	2,007	12,852	177,424	882
RENFREW	First or Upper	924	2	4,215	6	1,192	900	4,328	2,036	4 377	22 171	1,121	12,593	17,970	1 319
	Second or Lower	566	5	5,285	55	1,775	1,077	4,792	4,055	2,307	21 669	1,325	13,029	20,744	1 400
ROSS & CROMARTY	Black Isle	30	2,391	6 693		780	3 949	2,795	10,237	119	1 525	1,299	6,554	17,843	904
	Easter Ross	549	1,855	9,591		1,456	5 193	4,143	13 813	330	5,678	1,745	9,190	74,132	1,148
	Mid Ross	20	1,153	8,762		706	4,222	3 909	11,031	474	6 353	1,680	8,780	78,834	1,002
	S W and Western		13	1,776		590	193	1 518	469	1,363	2 434	361	4,020	69,481	38
	Lewis		2,110	4,193		3 618	175	139	146	406	9 652	1,203	11,891	50,906	13
ROXBURGH	Hawick & Liddesdale		103	3,414		154	1 777	1,272	5,244	3,683	13,699	555	5,298	187,506	449
	Jedburgh	12	1,778	7,223	1	267	4,654	2,635	17,081	1,363	16 914	1,069	7,208	158,499	779
	Kelso	295	6,133	8,012	19	588	6,843	3,405	16 538	856	13 949	1,247	7,692	143,543	1,521
	Melrose	45	1 211	5,579		179	3,544	1 756	11,097	754	13 350	682	4 101	74,807	827
SELKIRK (not divided)			229	3,758		147	2,152	1,108	6,832	2,417	12,785	566	3,962	191,497	525
SHETLAND	Mainland		610	5,069		1,632	878	1,018	585	1,326	8,223	1,537	8,738	118,144	191
	North Isles		13	1,175		410	113	325	81	545	3 041	1 078	2,712	33,400	69
STIRLING	Central	708	384	6,975	766	1,249	1,481	5,615	3,984	4 363	15 384	1,795	13,424	40,337	1,065
	Eastern	685	531	6,169	584	898	1,078	3,713	2,750	1,903	15 992	1,167	3,974	7,589	744
	Western	109	5	4,604	34	1,034	1,015	3,360	3,415	1,453	15,538	1 039	10,800	72,759	715
SUTHERLAND (not divided)			291	7,431		1,108	2,649	4,509	5,799	1 540	7 484	2,060	9,766	208,992	560
WEST LOTHIAN	Bathgate	212	289	5,174	3	640	1,193	5,209	2,837	774	13,519	1,105	6,570	8,258	237
	Linlithgow	1,823	1,552	5,264	25	1,866	1 994	3,364	2,391	386	8 618	1,021	5,184	12,477	1,477
WIGTOWN	Machars	10	124	10 064	72	327	4,365	4,482	20,535	4,175	30,736	2,432	27,574	69,869	4,492
	Rhins	2	47	17,727	18	1,211	7,339	2,473	31,820	1,218	15,914	2,792	29,761	54,468	10,387

* To be harvested as corn.

† See Note on p 119

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THE ERADICATION OF BRACKEN.

J. H. MILNE HOME.

MOST competent observers will probably agree that during the last twenty or thirty years bracken has been increasing on hill land in Scotland. The spread of bracken, when once the plant is firmly established, may be comparatively slow, but it is persistent and sure. Small patches of an acre or less can quite well double themselves within five to ten years. A considerable amount of literature bearing on the subject may be found in agricultural and scientific journals in recent years, and while there is much interesting and valuable information to be found in these papers, few, if any, go into details of cost. If the bracken pest is to be successfully dealt with, the owners and occupiers of infested land must be convinced that the destruction of bracken is financially and economically possible. Should the cost of eradicating bracken on a given area be greater than the capital value of the cleared ground the outlay involved cannot be financially profitable. Such instances may occur, but in most cases the value of the land after being cleared will be considerably greater than the cost of clearing.

The Directors of the Highland and Agricultural Society of Scotland considered the question of the bracken pest as far back as 1902, and their Minute of 3rd December in that year reads as follows:—

"The Minutes of the Science Committee of 3rd December relating to bracken on hill grazings were read and approved. The Minutes stated that the general information of the Committee was that, while the growth of bracken on hill grazings had undoubtedly increased in recent years, there was no need for any further investigations or experiments as to the most effectual means of combating the plague. The Secretary had issued over 120 circular letters to owners and occupiers of hill grazings, and in the opinion of the Committee it was made sufficiently clear in the large number of replies received to this circular letter that the only practicable and effectual means of keeping brackens in check is cutting the undeveloped brackens early in June. The Committee recommend that the Society offer two premiums (together not to exceed £30 in value) for bringing out machines or implements for cutting or destroying brackens; one prize to

be for an implement for hand use and the other for a machine for horse power."

A few years later one or two types of horse-drawn bracken-cutters were brought out and tried, but these never obtained extensive favour. Owing to the rough, uneven nature of the ground upon which brackens usually grow, and the presence of rock and loose stones, the wear and tear upon a machine of any weight must necessarily be heavy. A great deal of bracken-covered ground is so steep that horses would have difficulty in working any kind of machine. For these reasons cutting by hand has generally been adopted.

The *Journal of the Board of Agriculture* for October 1911 contains an article on the destruction of bracken. Particulars are given of the total cost of £350 incurred in clearing an area of 500 to 600 acres in Dumbartonshire, and of £190 for another area of 200 acres in Argyllshire.

In the *Transactions of the Highland and Agricultural Society* for 1916 there is an article by Mr. G. P. Gordon which gives a good deal of useful information as the result of experiments made in cutting bracken at different dates, and also in the use of sprays. The most effective spraying mixture was found to be a 5 per cent. solution of sulphuric acid applied by means of a knapsack sprayer. The solution was prepared by putting 2½ galls. of water into the sprayer and adding 1¼ lbs. of sulphuric acid of 1·72 gravity. Care would naturally have to be taken in handling and diluting this strong acid. The cost of eradicating by spraying is stated to have been one-third of the cost of cutting by hand, but the actual details of cost are not given in either case.

Spraying has not, as a matter of fact, come into use for destroying bracken, and various practical difficulties will suggest themselves in adopting this method. The contents of a 2½ gall knapsack sprayer would not go very far, and on many hillsides where bracken is growing water might have to be carried several hundred yards in dry weather. The carrying and mixing of the strong acid would also require great care, and progress must be slow unless there were at least two sprayers, one to be got ready while the other was in use.

It is probable that 100 gallons per acre is the lightest spray which could be applied, and this would involve filling the knapsack machine forty times for each acre covered; 50 lbs. of concentrated sulphuric acid would be required.

Although cutting with a horse mower, switching with sticks and wires, or spraying with sulphuric acid may all be possible methods of dealing with bracken on certain limited areas, cutting and mowing by hand, using a scythe or hook, must in the great majority of cases be the only practicable method of bracken destruction.

Before dealing with the question of cost in detail it may be of value to consider the reasons for the admitted increase of bracken in the past quarter of a century. Although there are not a great many references to the existence of bracken a century or more ago, it is fairly certain that the plant must have had a

wide-spread distribution throughout Scotland, especially in woods of oak and birch. Bracken will apparently grow at almost any elevation from sea level up to 1600 feet. It is most luxuriant, however, on fairly good, well-drained soil. Some writers have stated that bracken does not often grow on peat, but this is incorrect, as bracken will grow very strongly on peat if sufficiently dry. It is, however, much more quickly killed by cutting on peat soil. It is very often found on studying a hillside of say 500 to 1000 acres that certain very dense patches of bracken occur dotted over the whole face. These patches may vary in size from a tenth of an acre up to three acres or more. A survey of the bracken areas will usually show that the plant has established itself (1) on the sides of any small burns or hollows where the mineral soil underlying the peat is exposed and where the natural drainage is good; (2) on ridges or mounds on the flatter parts of the hillside where the mineral soil may or may not be exposed through the overlying peat, but where at any rate the peat is not water-logged or constantly wet. One area known to the writer clearly shows these characteristics. The hillside in this case is all heather of good quality except for the bracken patches. These patches are extremely dense and have spread slightly in recent years. The patches were all cut twice in 1925, and it is anticipated that they can be cleared of bracken within three years. It will be interesting to see whether the bracken is replaced by grass or heather. This instance illustrates the fact that bracken will not grow on wet ground, and it is therefore very probable that with an increase in hill drainage during the past half century has come a corresponding increase in the amount of bracken. This is naturally not an argument against hill drainage, but it does indicate the need of care in preventing an increase in bracken where scattered plants exist on ground that has been recently drained.

Another example of bracken increase is found where scattered plants exist among old heather. As soon as such heather is burned it is a common experience to find a great increase in the vigour of the bracken. Old heather is slower in springing than young vigorous plants, and unless there is a good crop of seedlings the ground may remain more or less bare for two or three years. This affords bracken the necessary opportunity to increase in density, possibly to such an extent as to smother the young heather. Over-burning of heather or grass undoubtedly encourages bracken where any plants exist.

On grass hills bracken usually grows in larger masses, sometimes covering a hundred acres or more in a single stretch and usually occupying the best of the ground. In such cases grass and every other kind of vegetation are killed out. The decrease in the number of cattle on hill grazings is said to be responsible for the spread of bracken on land of this type. There is no doubt that where brackens are thinly distributed over grass land, the treading and grazing of cattle, especially in June, do destroy a great number of the young shoots.

It has been observed that on ground where rabbits are very numerous the spread of bracken seems to be encouraged. Probably this is due to the loose soil thrown up from the burrows forming a

favourable medium for the spread of the underground roots or rhizomes. Although bracken produces thousands of spores, it is found that only on rare occasions do these contribute to the spread of the species. This is accomplished almost entirely by the underground roots. Bracken is said to dislike lime in the soil, but this fact is of no service as a means of getting rid of the plant. It is not possible to lay down lime over large areas of hill land.

Observations as to the best date for cutting show that it is better to be a little late than too early. Theoretically the right stage for cutting is when the plant had made its full growth and before the stem has commenced to get hard. In practice where large areas are being dealt with it is best to begin a week or ten days earlier, at say the second or third week of June, and continue for about four weeks Second cuttings when necessary should be made about five to six weeks after the first cutting. A good deal of money and labour has been wasted in the past in casual or spasmodic cutting of bracken instead of following a regular prearranged scheme. It is of no value whatever to make one cutting at the right season if it is not followed up by systematic cuttings, each at the right time. Bracken cut after it has become hard in the stem may be useful for bedding and litter, but the plant is not weakened. Only the cuttings made at the stage when the root has put its stored-up supplies into the fronds and has not had time to receive fresh nourishment from the leaves are really effective and most rapidly weaken and exhaust the plants.

The following particulars relate to bracken cutting done between 1911 and 1915. The work was done at days' wages, but at a period when the weekly wage was 18*s.* to 20*s.*

Farm No.	Acres	Total Cost.	Number of Years.	Number of Cuttings.	Cost per acre
		£ s d			s d
1	41	28 10 8	5	6	13 11
2	153½	91 4 4	3 and 5	4 and 6	11 10
3	56	50 2 2	5	6	17 11
4	40	28 5 6	5	6	14 1
4	39½	15 3 1	3	3	7 8
5	50	38 18 7	3 and 5	3 and 6	15 7
6	17½	6 12 7	3	4	7 7
7	58½	22 17 1	1 and 2	1 and 2	7 9
	456	281 14 0			12 1·5

Farm No. 1 is mixed heather and grass. By the time the final cutting was made in 1915 the brackens were very small and could scarcely be cut. Although ten years have elapsed since the last cutting was made the hill has remained fairly clear, and only here and there are brackens beginning to grow again. Probably an outlay of 2*s* per acre would suffice to cut what plants are now showing.

The cutting on farm No. 2 was made almost wholly on grass land. The brackens were extremely thick and more or less in a mass. After ten years patches extending to perhaps 7-10 acres are beginning to grow again, but the plants are not more than 2 ft.

to 2 ft. 6 in. in height. Another cutting in 1926 should probably be sufficient to check them for some considerable time.

On farm No. 3 the area cleared was on a steep dry grass hillside facing east. The cost was highest on this farm, but the result has been the most completely successful. Only a few small brackens here and there are visible, although there has been no cutting since 1915. The ground is now closely grazed by sheep, whereas previously sheep could not penetrate at all over large areas.

The results on farm No. 4 are interesting for the reason that the area of 39½ acres required cutting only once in the first year and the brackens were got rid of in the third year. The ground still remains clear.

The cost of cutting on No. 5 is fairly high. The ground is steep and consists of mixed heather, blaeberry and coarse grass. The brackens have not come strongly, but owing to the nature of the ground they could not be thoroughly cut, and further attention is required now.

Nos. 6 and 7 do not call for any remark, except that in the case of No. 7 the brackens, although very much weakened, were not by any means cleared, the outbreak of war making the completion of systematic cutting impossible.

Bracken cutting was resumed on new areas extending in all to 500 acres in 1923-25. A somewhat different method of procedure has been followed which has on the whole been found to work satisfactorily. The areas to be cleared are plotted on the Ordnance Survey and a plan made of each, the area or areas being carefully calculated. The work of cutting is then let by contract, the rates paid varying with the nature of the ground from 2*s.* 9*d.* to 3*s.* 6*d.* per acre, at which a man working steadily can make a good wage at current rates. Two to three acres per day is the area usually cleared by a competent man. The largest area is cut with the scythe, but men not accustomed to the scythe can make very good work with a hook on a handle sufficiently long to avoid stooping.

The exact area cut in 1925 was	499¼	acres
of which there was cut a second time ...	74½	„
Equal to a single cutting of	574	

The total cost was £82, 18*s.*, equivalent to rather less than 3*s.* per acre for each cutting. This is a low average rate, the reason being that most of the cuttings were in the third year, and consequently were much more easily overtaken. The details for two farms are given below, illustrating two totally different types of land:—

Farm No.	Acres.	Total Cost. £ s. d.	Number of Years.	Number of Cuttings.	Cost per acre. s.	Cost per Cutting. s. d.
8	47	61 11 3	3	5	28	5 7
9	166¾	87 7 11	3	4	10	2 6

The ground to be cleared on No. 8 farm was extremely rough, being covered with scattered birch trees, rocks and stones, with strong old heather growing where the bracken was not too thick. The situation was also some miles from the nearest point where labour could be obtained.

In the case of farm No. 9 the land adjoining the areas cut was partly grass and partly short heather. The cutting was fairly easy and much quicker progress could be made. It cannot be said with certainty that no further cuttings will be necessary. Probably one more cutting in 1926 may be desirable, and if made it should be sufficient practically to eradicate the bracken.

The rental value of the land on the nine farms enumerated varies between 3*s* and 7*s*. per acre. It is sometimes the lowest rented land that is the most expensive to clear.

It is important to note that the labour employed in bracken cutting was in no case the ordinary farm staffs. Bracken cutting has to be done at about the busiest period of the year on a hill farm, and the only spare time is in wet weather when it is not possible to work at hay. It is, however, useless to attempt to deal with bracken merely on wet days in hay time. If the weed is to be got rid of it must be cut systematically at the proper dates whether the weather is wet or fine. Extra labour must be employed for the purpose.

The experience gained from the clearing of bracken before and since the war seems to justify the following conclusions :—

(1) Bracken can be practically eradicated from hill ground by systematic cuttings over a period of from three to five years.

(2) When cuttings are commenced it is essential to continue them at the proper season each year until the desired result is obtained. To interrupt the work even for a year, after one or two cuttings have been made, is practically to throw away the work already done.

(3) The ideal stage for cutting in order to weaken the plant to the maximum extent is when the height growth is completed and before the stems become hard. In practice it is necessary to begin about ten days before this stage is reached and finish within about three weeks. The date at which the brackens will be ready for cutting may vary from the middle of June to the beginning of July according to the season.

(4) Cutting by hand labour with a scythe or hook is the most useful method of clearing and enables most ground to be covered. The use of a horse mower may be possible in a limited number of cases, and sticks or wire switches may be useful among stones. Spraying with sulphuric acid is scarcely practical on any scale unless ample water is obtainable close at hand.

(5) The cost at the present rate of agricultural wages will vary, according to the number of cuttings required and the situation and nature of the area, from 10*s*. to 30*s*. per acre.

(6) Where the probable cost of clearing bracken exceeds, say, five years' rental value of the land, there may be some

doubt as to the financial justification of the outlay. It must be remembered, however, that bracken always occupies the better land on a hill, and that a number of sheep are lost where large areas of bracken exist. There is also the certainty of spreading to consider.

(7) The measurement of the areas to be cleared and letting the work by contract is the most economical and efficient method of getting the work done where supervision is necessarily rather difficult.

The argument is sometimes advanced that cutting bracken is not an operation which a tenant should undertake as it effects a permanent capital improvement to the farm. It may be argued on the other side that the tenant is the person who reaps the immediate advantage, and if there happens to have been an increase in the extent of bracken during his tenancy, it is not unreasonable that he should do something towards reducing the bracken area.

It may be useful in considering this question to state that of the area of 500 acres above referred to as now in course of being cleared, 417 acres is let under ordinary agricultural leases, and the cost of the bracken cutting is being mutually borne by landlord and tenant. The benefit already obtained has so clearly justified the expenditure that if more labour had been obtainable an even larger area would have been dealt with at the request of the farm tenants.

SOIL PHYSICS AND ITS BEARING ON PRACTICE.

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THE physical properties of his soil are of the utmost importance to the farmer. In every one of his cultivation operations, and during the growth of his crops from seed time to harvest, he is either taking advantage of favourable physical properties or endeavouring to circumvent unfavourable ones. Some of them are beyond his control, but many others can be modified either directly or indirectly, and the better his understanding of these physical properties and their effects, the less likely is the farmer to be at the mercy of weather vagaries and the peculiarities of his soil.

The accumulated experience of many generations of husbandmen has given the present day farmer a satisfactory working knowledge of his art, and if he were independent of financial considerations he could almost invariably obtain good results no matter how difficult his soil and weather conditions might be. But in practice costs dominate the situation at all times, and in periods like the past few years this side of farm economics becomes paramount. It will be agreed that the more exact and detailed our knowledge of any process and its effects, the easier it will be

to reduce its cost to the minimum, maintaining at the same time the maximum level of efficiency. Exact knowledge can be obtained only by scientific investigation, in which all the factors are taken into account in order that their relative importance and relations to each other may be ascertained. This is the justification for a study of the physical properties of soil in view of their paramount importance in cultivation operations. There are two possible methods of attack. The first may be called the fundamental method, in which the aim is to build up a definite science of soil physics. In this method—which presupposes trained specialists, modern equipment, and a research atmosphere such as exists in a university laboratory—the fact that one investigation may have a more immediate practical application than another is merely incidental; whereas in the second—or empirical—method of attack it is precisely these problems alone that are considered, and the aim is to obtain a working solution as quickly as possible. Both methods have obvious advantages and disadvantages. Empirical solutions, by their nature, are incapable of rigid definition and complete scientific explanation. They are never certain, and have a disconcerting habit of failing when applied under slightly different conditions On the other hand, many problems have to be treated empirically owing to the present undeveloped state of soil physics. In these circumstances the best method is to proceed steadily with the fundamental researches, applying them to practical problems whenever possible, and to have recourse to empirical means for those problems that do not at present appear capable of explanation and solution by strictly scientific methods.

In the present article it is proposed to illustrate this policy by considering some of the physical investigations carried out at Rothamsted in recent years.

Factors affecting the draught of Implements.—Naturally, much of the work has been devoted to soil cultivation problems. These are being studied both in the laboratory and the field. The field work has been much facilitated by the use of a dynamometer; this instrument is a special type of spring balance, provided with a mechanism that records on a moving paper band, the drawbar-pull, or the force needed to draw an implement through the soil, the speed of the implement, and the distance it enters the soil. The records, when properly analysed, provide full information on the behaviour of the implement, and enable comparisons to be made, for instance, between the efficiency of different implements on the same soil, or of the effect of manuring in altering the drawbar-pull, both of which have economic importance. At first our results were more than usually puzzling, for they bore little relation to one another, and in some cases seemed to conflict with well established facts. After further trials it was found that the discrepancies were due not to any inaccuracy in the dynamometer, but to inherent variations in the soil of the fields under test. This was an unexpected discovery, because to visual inspection the fields were very uniform, and would have been in fact selected by a committee of practical men as quite suitable for a competitive trial of different implements. Nevertheless, dynamometer measurements showed that the resistance of the soil differed greatly from

one point to another. The range of variation was no less than 40 per cent., and even when the *average* drawbar-pull of wide strips was taken, there was still a 10 per cent. difference. The bearing of this result on all competitive trials is obvious, for no reliance could be placed on the results unless the field had been previously tested with a single plough and a dynamometer, so that its inherent variations in resistance could be mapped out and allowed for in the subsequent comparisons. Fortunately our experiments show that these variations persist practically unchanged from one season to another, so that the preliminary survey could be made in a previous season if necessary.

The matter just discussed merits the close attention of all those interested in the design of implements, in order that misleading results shall not be obtained when any new pattern is tested in the field.

Besides the actual resistance of the soil, other factors come in to determine the total resistance offered by the implement. The relative effect of these has been separately studied. Maladjustments in the hitch of the plough have little effect on the drawbar-pull except in so far as the effective depth of working is changed. This latter factor was tested independently with the plough set correctly, and the drawbar-pull was found to be proportional to the depth, the increase from $4\frac{1}{2}$ in. to 6 in. being about 25 per cent. The increase would of course be considerably greater if a plough sole or pan were encountered. The possible effect of a gradient in the field on the drawbar-pull was examined by comparing the records for adjacent furrows ploughed up and down the slope. There was no measurable difference for gradients of less than 1 in 40. At first sight this result appears to conflict with practical observation, since the increased effort exerted by either a horse or a tractor working uphill is very obvious. But this is mainly due to the raising of its own weight, and the dynamometer takes no account of this because it only records the total resistance offered by the plough. Hence, as far as the latter is concerned, the extra drawbar-pull uphill is only that due to raising the weight of the plough. For a 300 lb. tractor plough this is only 7 lb. on a slope of 1 in 40, an insignificant increase over the drawbar-pull on the level, which would be of the order of 1000 lbs.

The economic advantages of increased speed.—Perhaps the most important result of the experiments was the demonstration that the drawbar-pull was but little affected by the speed of the work. Thus the resistance offered by the soil to a tractor-drawn plough at 4 miles per hour was only 7 per cent. greater than the value at $2\frac{1}{2}$ miles per hour. The cost of the extra fuel needed to sustain this 7 per cent. increase in the drawbar-pull would be only a small fraction of the saving in labour costs by ploughing at the higher speed, because a 60 per cent. greater area would be ploughed in the given time.

Hence, on purely economic grounds, it is cheaper to perform cultivations at as great a speed as possible. Practically, limits are set by the wear and tear on the present type of tractor, and the unsatisfactory work done by implements working beyond their designed speed. Improvements in design would obviate this

difficulty, and there is a promising future for both implements and tractors capable of working satisfactorily at speeds of at least 6-7 miles per hour, i.e. comparable to those already achieved with steam cultivating tackle. Apart from the direct economic advantage, the ability to complete cultivations at a rapid rate is especially valuable. It helps greatly in getting the urgent work in autumn or spring well forward, especially in difficult weather, where the opportunities for getting on the land may be limited; and for winter-sown crops the completion of the work in good time may be vitally important. Thus, in one experiment the yield of wheat from the area sown in November was 27 bushels per acre, but where sowing was deferred until February because cultivations could not be done in time, the yield was reduced to below 20 bushels.

At first sight it may appear that the question of speed of working has little interest except for the farmer who uses some form of mechanical cultivation; but the principle applies equally to horse traction, although the benefit is more indirect. An illustration may be given of this, of especial interest to Scottish farmers. Some eighty-five years ago Philip Pusey, M.P., using a crude dynamometer, compared the draughts of a number of ploughs. He was much puzzled because on all types of soil the famous Scotch plough gave an invariably *higher* draught than the best English patterns. In view of its great reputation—based on the larger area ploughed per day by the Scottish ploughman as compared with that done in England—Pusey had expected to find a very low draught, and certainly not a higher value than that of the English plough. However, when he did further tests on the relation of draught to speed, and found that there was no appreciable increase of resistance, the solution of the puzzle was obvious. The Clydesdale horses that drew the Scotch plough walked at a brisker pace than the English teams, and although the draught of the implement was greater than it need have been, it was well within the capacity of the team, and did not, of course, increase with speed of working. The merit attributed to the Scotch plough therefore should really have been awarded to the Clydesdale horses; they did the work, but the plough took the credit!

The general rule that emerges, applicable to all types of cultivation, and to both power and horse drawn implements, is that the increased resistance of the soil is not a serious limiting factor to increased speed of working. The principle applies of course to hand-hoeing as well, and is thus of special interest on experimental farms and for certain crops grown under intensive or market-gardening conditions, where hand labour has to be employed. There are patterns of wheel-mounted hoes on the market that enable weeding or surface mulching to be done at a much greater speed than is possible with the usual hoe. In tests made by the Farm Director at Rothamsted on the permanent experimental wheat plots at Broadbalk Field, the speed of working was increased threefold with the wheel-hoes; even when allowance was made for the time needed to remove with an ordinary hoe those weeds growing in the wheat rows that could not safely be removed with the wheel-hoe, the work was still done at over twice

the usual speed. The cost per acre was reduced by over 50 per cent., as besides the saving of time it was possible to employ unskilled and therefore cheaper labour. In view of the strong and stony nature of the soil the test was a convincing one, and on more favourable land even greater reduction would be possible.

Methods of reducing the soil resistance.—In addition to reducing effective costs by increasing the speed of working, it is possible by suitable treatment to reduce the actual resistance offered by the soil to the implement and thus to lower the cost of cultivation. This can be done both by improved implement design, or by treatment of the soil so that its inherent resistance is decreased. The question of implement design is rather beyond the scope of this article, but it is important to point out that it is by no means a purely engineering question. It involves a detailed knowledge of the physical properties and behaviour of the soil itself, in order that the agricultural engineer may be given a complete specification on which to base his design. At present he has this—under the name of "properties of materials"—only for the materials of which the implements are constructed, and his knowledge of the soil properties on which the efficiency of the implement ultimately depends is very largely empirical It is the purpose of Soil Physics to substitute for this empiricism a scientific knowledge of such factors as the cohesion and plasticity of soils, and above all to provide more information about that all important but little understood property, defined by the practical man as "good tilth."

The question of reducing the resistance offered by soil admits of a more direct investigation. The beneficial effect of any organic manure in this and other directions has been known for a very long time. Our results show that the power needed to plough soils that have received ample supplies of farmyard manure is reduced by over 20 per cent. in comparison with the same soil unmanured. Another well known remedial treatment on heavy land is the application of lime or chalk. The beneficial effects of these materials on acid soils is discussed separately below; they also have a valuable effect in lightening the draught of implements. Thus a heavy application of chalk (20 loads per acre) was made some years before the war on certain fields at Rothamsted, unchalked strips being left for comparison. A number of tests were made on these fields, and under different conditions, with the following results:—

	Drawbar pull in lb.		Percentage reduction.
	Unchalked.	Chalked.	Unchalked = 100.
Early autumn; land dry ...	473	476	Not significant.
Late autumn; land moist ...	924	802	13·0
Spring cross ploughing; land moist	521	461	11·5
Early winter; land very wet ...	1258	1181	6·0

The table shows that, when the land is dry or wet, chalking

has little effect on the draught, but in moist conditions it acts strikingly. These results were obtained over 10 years after the actual application of chalk to the land, and there is every indication that they will continue to be obtained for some time to come. The aggregate saving in power—whether mechanical or horse—over this period is very considerable, and constitutes a valuable credit item to set against the present heavy cost of chalking. One may take, as a simple illustration, the case of heavy land, where the need for an extra horse in the team would be obviated by the reduced draught following on the chalking.

Before leaving the subject of reducing the draught, and therefore the cost of existing cultivation operations, a further method, differing in principle from those already discussed, should be mentioned. It depends on the fact that when an electric current is passed through soil the soil moisture moves towards the negative pole. Hence, if the share and mouldboard are made the negative pole, a film of water is deposited on them, and a lubricating effect is obtained, with a resulting reduction in draught. Although the method is still in the experimental stage it has been tried with encouraging results under field conditions, the current being supplied by a dynamo carried on and driven by the tractor.

When the current was switched on the speed of the tractor increased, showing that the reduction of draught due to the water film lubrication was greater than the loss of direct drawbar pull due to the power absorbed in driving the dynamo from the tractor engine. The method promises to be specially useful for soils that "scour" badly and thus clog the mouldboard.

Physical factors of importance in cultivation.—Up to this point attention has been mainly confined to questions of reduction in power needed for existing cultivation operations; the next point that arises is whether these operations can be modified in any way, so as either to reduce their number or to increase the crop yield. Here we enter upon a practically unknown territory. In comparison with the large number of manurial experiments done at farm institutes and colleges in the past half century, the number of cultivation experiments is negligible. Probably the reason is that good cultivation is so obviously necessary for a satisfactory crop that there is a natural reluctance to modify any of the operations for experimental purposes. But there can be no certainty that our present methods are the best and most effective that could be devised; and with cultivation costs figuring more heavily than manures in the expense side of the farm balance sheet, there is ample justification for their scientific examination. Cultivation is a very old art; its practices have survived the test of time and are not to be changed by some magic wand of science. The business of science is carefully to examine these practices in the first place, and to endeavour to arrive at a full explanation of their effects on the soil. Until these facts are in his possession the expert will be unable to suggest improvements and simplifications. Hence, one of the most important investigations is into the matter of soil tilth. A discussion of this complex work would be beyond the scope of the present article; it is being studied at Rothamsted by no less than seven different but converging

methods, and encouraging progress has been made. Meanwhile other physical properties of soil directly connected with cultivation have been examined.

In ploughing operations there are two fundamental properties: the cohesion of the soil, which in loams and clay soils increases greatly as the moisture content becomes less, and the friction of the soil on the metal surface of the mouldboard, which, fairly constant up to 12 per cent. of water, increases beyond that point until the soil becomes really wet, when the friction falls. Hence the soil shows its least resistance at some intermediate moisture content, where neither friction nor cohesion have attained high values—an explanation of the fact already known to the ploughman.

The case of surface cultivations and harrowings has also been examined. It is well known that these operations have most effect if done when the wet soil has been dried and moistened again. The explanation is found in the colloidal properties of the soil. A wet block of soil is plastic like potters' clay. As it dries out the colloidal material shrinks, and at a certain point air is able to enter the mass. When it is again remoistened the colloidal material does not swell to the same extent, and thus spaces are left in the interstices of the block which, aided by the imprisoned air, readily falls to pieces under the cultivating tines or harrow teeth.

Surface cultivation to create a dry mulch, which will conserve moisture in the soil, is of great value in dry districts, and some recent Rothamsted results show that its importance has not been sufficiently emphasised. There is a prevalent idea that the soil can draw by capillary attraction to a large extent upon the water stored in the lower depths of soil, which thus constitutes a reservoir in periods of drought. The idea is correct, but the range of action of the capillary pores is not great. With the use of a special type of cylinder, provided with an arrangement for measuring the position of the under ground-water level, it was shown that the ranges of capillary action did not exceed 3½ feet. This figure was obtained in a clay soil and over the great drought of 1921, where the sustained evaporation conditions at the soil surface permitted the water-raising power of the soil to show to advantage; in normal years, and for lighter soils, the value would be considerably less. This result emphasises the vital necessity of surface cultivation in order that the somewhat limited store of moisture in the top layers of the soil may be prevented from evaporating from the soil surface.

Soil acidity.—One of the greatest technical questions at present is soil acidity. Large areas of land in Britain are either definitely acid or in danger of becoming so in the near future. Some 50 to 70 years ago the cost of heavy applications of chalk or marl became too great, and the practice was largely given up. At the present time the reserves of lime in certain areas are becoming exhausted, and acid conditions will inevitably follow. The earlier work on soil acidity was based on the assumption that definite and fairly simple acids were present, and methods were devised to measure the amount of lime needed for neutralisation. The disagreement between the results of these methods, coupled

with further research work into the nature of soil acidity, showed that such simple tests were misleading. It is now recognised that soil acidity—self-evident though its effects on crops may be—is the result of very complex processes. In the final result two factors have been distinguished—an "intensity" factor and a "quantity" factor.

A very rough idea of the meaning of these terms may be obtained by considering the same volume of similar concentrations of two acids, one strong, such as nitric or hydrochloric acid, and the other weak, such as acetic or citric acid. The "quantity" factor in the two cases would be similar. but the "intensity" factor would be much greater for the strong acid. So in the soil: on the intensity factor depends the characteristic signs of soil sourness (typical weed flora, failure of leguminous crops, fungus diseases of cruciferous crops); the quantity factor controls the amount of lime necessary to correct the acidity. The intensity factor is capable of accurate measurement in the laboratory, but the quantity factor depends greatly on the nature of the soil, and before any definite method can be standardised for measuring the "lime requirement' of a given acid soil, it will have to be practically tested in very careful and reliable field experiments.

Meanwhile, direct field experiments have given a certain amount of empirical information to the agricultural organiser and advisor, and it is possible, by a judicious application of small amounts of lime once in a rotation, to keep the acid sensitive crops from harm, in cases where the soil is not too acid to begin with, without going to the expense of heavy applications. At the same time this method is only a palliative, and, in view of the appreciable and lasting credit item due to reduction in draught of implements following a liberal chalking, the advantage of securing this, and freedom from acidity troubles at one and the same time, is not to be despised.

EXPERIMENTS ON MAKING HAY WITH HEATED AIR.

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THE subject of the artificial drying of crops by means of an air blast, either unheated or heated, has been receiving so much attention and publicity in recent years that it is evident that it is considered to be a matter of much practical importance. Inventors have put forward systems for drying hay and other crops in the stack by means of a current of air blown or drawn through the stack by a fan. Such experiments have been much discussed and have received a great deal of attention both in the agricultural and the general press. If an economical system could be devised it would be of great benefit, particularly in a country such as ours, with a cool and uncertain climate. The main advantages claimed for such systems of artificial drying are, first, that they render the farmer independent of bad weather; second, that the crops treated in this way are less subject to damage and loss through handling;

and third, that such crops are of better quality and of higher feeding value.

Experiments have been carried on for a number of years at Craibstone, the experimental farm of the North of Scotland College of Agriculture, on the drying of crops in the stack by means of an air blast. Before 1925 cold air was blown through the stacks, and no success in the making of hay and little success in the drying of corn was obtained. Some account of these experiments has already been published.[1] In 1925 a series of experiments was carried out upon hay at Craibstone in order to test a system of drying with hot air which has been devised by the Institute of Agricultural Engineering at Oxford. The machines used in this system are covered by patents in which the Institute of Agricultural Engineering and Mr. C. Tinker, Kilmartin, Inverness-shire, are jointly interested.

Although the experiments have been carried out for one season only, the Governors of the College of Agriculture decided that an account of the results should be published at once. In taking this step they had in view the fact that much publicity has already been given to experiments carried out elsewhere with this system for which a very high degree of success has been claimed. Although accounts of these experiments have appeared in the press and in pamphlets, few details have been given. At Craibstone careful record was kept of the details of the experiments, including the amount of material used, the analysis of the crop before and after treatment with the air blast, the number of hours during which the stacks were blown, the temperature inside and outside the stacks, the consumption of paraffin, and the cost of fuel per ton of hay. Although it is too early to draw any final conclusions from experiments made during one season only, the results may be of importance as a guide for the future and as an indication of the direction in which improvement is still to be sought if this system is to become a commercial success.

One pamphlet dealing with the Oxford system and called "The Crop Drying System," states:—"The system is now placed on the market after being successfully used during 1924, a year which will long be remembered by farmers on account of the great quantity of crops ruined by continuous rain. The subject of costs has been carefully investigated, and the results, based on experience with a great number of stacks composed of various crops, show that even in a good harvest season the crop drying system represents a saving over ordinary methods; in a wet harvest season the saving is increased many times, and, in fact, represents occasionally the difference between a harvested crop and a crop left to rot in the fields." Later in the pamphlet a comparison is given of the costs of making hay by this system and by the ordinary method. In this it is estimated that the cost of hay making, whether in a good or in a bad season, by the Oxford method is 12*s.* 6*d.* per ton, of which 2*s.* 6*d.* is the cost of the artificial drying. On the other hand it is estimated that hay

[1] "Artificial Drying of Crops in the Stack," by Professor James Hendrick, *Trans. of the Highland and Agricultural Soc. of Scotland*, 1924, 5th Series, vol. xxxiv, pages 141 and 160.

making by the ordinary method will cost from 13*s*. 6*d*. per ton in a good season to 18*s*. per ton in a bad season. It is further stated, "The figure given for drying is 2*s*. 6*d*. per ton, but experience has shown 1*s*. 6*d*. to be a more usual figure." Comparative analyses of hay made by the artificial system and by the ordinary method are given, and these show that the hay made by artificial drying is superior in quality to that made in the ordinary way. The same thing is also stated in the text.

The Crop Drying Co., Ltd., which has offices in London, was formed for the purpose of placing upon the market the plant required for carrying out the Oxford process. This Company readily undertook to supply the necessary plant for a demonstration at Craibstone if the College authorities would supply the crop, the fuel required for the machines and the cost of transport of the machines to Craibstone. It was considered by the Company that our electric supply at Craibstone was not sufficient to drive the machinery and that it would be better to use a tractor. They recommended the use of the "International Junior" tractor, but as it was not found possible to obtain one of these on loan at the time we required it, a Fordson tractor was obtained instead, with the approval of the Crop Drying Co.

At the beginning of July two sets of plant were sent to Craibstone by the Crop Drying Co.: (1) a Matthews & Yates' plant, which was brought from England by two representatives sent by the Director of the Institute of Agricultural Engineering at Oxford to supervise the working of the plant and to assist with the demonstrations; (2) a plant from Glasgow manufactured by Messrs Shimwell, Alexander & Co. and supplied through Messrs. Telford, Grier & Mackay, Ltd, who also sent a representative to Craibstone to see that the plant was properly installed and used. In a letter from the Crop Drying Co. the reason for sending two machines is given as follows:—"I beg to inform you that it is proposed to employ a Matthews & Yates' plant together with one manufactured by Messrs. Shimwell, Alexander & Co., with the full approval of the latter firm. The reason for this is that Messrs. Matthews & Yates' machine has been thoroughly tested and found to be highly efficient, whereas Messrs. Shimwell, Alexander & Co's machine has lately incorporated several modifications which through lack of sufficient time have not yet been tested as fully as is desired." Each machine had spare burners with it, so that it was possible to change the burners whenever those in charge of the plant considered any of them to be inefficient. A speed counter was also sent so that those in charge could count the revolutions of the fan to ascertain whether it was working at the desired speed.

Three experiments were made on three different stacks and during the course of these experiments both machines were used. The stacks of undried material were built round large central bosses. The bosses used were supplied by the Crop Drying Co. The drying is done by blowing a strong current of heated air into the centre of the stack through a large flexible duct connected with a metal duct, a trench being cut to allow the latter to be carried just under the surface of the ground into the middle of the stack, where it opens into the central

boss. The air which is driven by the fan through the duct into the stack is heated in a "heating unit," which forms the essential feature of this system. The heating unit is furnished with two large burners, into which paraffin is forced under pressure from a tank supplied with a pressure pump. The strong flame produced in this way heats two S-shaped tubes which are lined with fireclay, and the fan draws the air over the heated tubes in such a way as to bring the air current into contact with a large amount of heated surface. The air which is blown into the stack is in this way heated to a temperature much above that of the surrounding air. During the experiments at Craibstone the temperature of the air blown into the stack varied from just under 100° F. to over 130° F. Measurements were frequently made of the temperature of air which was blown into the stack and it was generally found to stand about 120° F. The products of combustion from the burners were not blown into the stack, but after passing through the S-shaped flues escaped from a flue at the top of the heating unit. The temperature of the gases escaping from this flue was found to be very high. The statement has been made that most of the heat of the paraffin burners is used in drying the stack and that the gases escaping from the flues are comparatively cool This was not found to be the case, but as only ordinary mercury thermometers were available no accurate measurement of the temperature of the flue gases could be made.

The heated air blown into the centre of the stack finds its way out through the materials composing the stack, carrying out moisture with it, and in this way drying the stack. The central boss is made in such a way that there is not too thick a layer of material at any one point, so that heated air will pass through all parts of the stack.

The first stack was intended to be merely a trial one to see that everything was in order. The College authorities were holding demonstrations for farmers at Craibstone during the early part of July, and the intention was to dry this stack before farmers arrived for the demonstrations, and to proceed to dry other stacks during the time farmers were present so that the process might be demonstrated to them.

The following table shows some of the chief data the three stacks which were used in the experiment:—

TABLE I.

Hay Drying Experiments, 1925.

	Stack No. 1.	Stack No. 2.	Stack No. 3.
Date of Cutting	July 2nd	July 6th	July 9th
Date of Building	July 4th	July 8th	July 10th
Diameter of Stack	14 ft.	12 ft.	12 ft.
Height of Eaves	11 ft.	10 ft.	10 ft.
Height over all	21 ft.	20 ft.	20 ft.
Weight of Green Material ...	9 tons 4 cwts.	5 tons 17 cwts.	8 tons 9 cwts.
Weight of Hay calculated to 13 per cent. moisture ...	...	2 tons 15 cwts.	2 tons 11 cwts.
Quantity of Paraffin used ...	201 galls.	84 galls.	112 galls.
Cost of Paraffin	£12, 2*s*. 10*d*.	£5, 1*s*. 6*d*.	£6, 15*s*. 4*d*.
Cost of Paraffin per ton of hay	...	£1, 17*s*.	£2, 13*s*.
Total hours of blowing ...	31	18¼	22

The weather during the experiments was unsettled and some rain fell from time to time; it was not such, however, as to prevent hay being made in the ordinary way, and the greater part of the ordinary hay crop of the farm was saved while the experiments were in progress.

The green stuff built into stack No. 1 had been cut on Thursday, July 2nd, and was withered and partially dried before it was built into the stack on Saturday, July 4th. The stack was built early on Saturday and blowing commenced at once The Oxford representatives in charge of the machines were of opinion that they would be able to complete the drying before night and they continued to blow for 18 hours, when it was found that the stack was still moist and they ceased working. Blowing was resumed on Sunday and continued for nine hours, and again it was found that the stack was not yet dry. On Monday it was blown for a further four hours, when it was found to be still quite damp. Stack No. 2 was then taken in hand, and later, as shown further on, another attempt was made to dry No. 1 stack, but as it had heated badly and was getting mouldy it was eventually taken down and spread out. Drying was completed in the ordinary way, but any hay obtained was of inferior quality. Nothing more need be said about this stack, which was looked upon merely as a preliminary trial.

It was considered advisable to make stack No. 2 of considerably smaller size. The green material which was built into it was cut in the afternoon of Monday. 6th July, and the stack was built on the morning of Wednesday, the 8th July. The green material was by that time withered and partially dried, and contained 40·4 per cent. of dry matter and 59·6 per cent. of moisture. Its analysis is given in Table II. Blowing was started at 10.45 a.m. on the 8th and continued till 1.15 a.m. on the 9th, when, as the stack was not dry, operations ceased. Blowing was started again at 11.45 a.m. on the 9th and continued till 3.30 p.m. on the same day,

TABLE II.

Analysis of Samples, Grass and Hay.

	Stack No. 2.		Stack No. 3.		Hay made in ordinary way.
	Original Material	Hay from Stack.	Original Material.	Hay from Stack.	
	Per cent	Per cent.	Per cent	Per cent	Per cent.
Moisture	59·60	13·00	74·0	19·40	20·10
Ether Extract	1·18	2·17	0·52	1·58	1·37
*Albuminoids	3·80	7·92	2·31	7·44	7·94
Soluble Carbohydrates ...	21·45	45·85	13·98	41·77	37·42
Fibre	11·66	24·93	7·67	24·35	28·22
†Ash	2·31	6·13	1·52	5·46	4·95
	100·00	100·00	100·00	100·00	100·00
* Total Nitrogen	0·61	1·27	0·37	1·19	1·27
* Protein Nitrogen	0·51	1·09	0·32	0·93	1·14
† Including Siliceous Matter	0·19	1·20	0·18	0·79	0·54

18¼ hours in all. The stack was then considered to be dry. It was cut open on one side and a large wedge of the material taken out. This was found to be very dry in the inside, where it was considered by practical men to be much too dry, as on handling it was brittle and easily powdered. On standing this brittleness would doubtless have disappeared owing to the absorption of moisture from the air. From the middle to the outside it was sufficiently dry. An average sample of this portion which was cut out was found to contain 13 per cent. of moisture. Its analysis is given in Table II. During the 18¼ hours of blowing, 84 gallons of paraffin were consumed. By far the greater part of this was used by the burners to heat the air, only a comparatively small part being used by the tractor to work the fan. The paraffin was purchased in bulk and cost 1*s.* 2½*d.* per gallon, so that the cost for paraffin alone was £5, 1*s.* 6*d.* If we convert the weight of green material put into the stack into terms of hay containing 13 per cent. of moisture, we find the stack contained 2 tons 15 cwts. of hay, and therefore that it cost 37*s.* per ton for paraffin alone to dry the green stuff into hay.

Probably some economy might have been effected in two directions. (1) By blowing continuously till the stack was dry, for by allowing it to cool down over night, when blowing ceased, some heat was no doubt wasted. (2) When the stack is nearly dried and is quite warm owing to the action of the heated air, no doubt the drying might be completed by blowing cool air through it. Probably in that way the time of heating might have been shortened about an hour and a little paraffin saved.

The dried hay was cut out of the stack on the east side, and after the remainder, and larger portion, of the stack had been standing for about a week it was found to be heating. On examination the whole of this portion was found to be more or less damp, and it was going bad and becoming quite slimy in parts. So far as could be seen the portion which had been really dried into hay did not extend far beyond the wedge which had been cut out of the stack During the experiment the wind was almost constantly westerly, and the probability is that the heated air was carried over mainly to the east side of the stack by the natural air pressure of the wind. This might account for the fact that it was only the east side of the stack which was found to be dried. This stack also had therefore to be taken down. In this case the result of the drying, which was at first considered satisfactory, was found to leave much to be desired.

The green material for the third stack was cut on Thursday, 9th, and after the success which it was supposed had been achieved with the second stack, the representatives from Oxford, who were in charge of the plant, were anxious to proceed with material which was still quite wet and which had not been partially dried by lying for more than a day in the field. The third stack was therefore built on the morning of Friday, July 10th. As there had been rain during the night and the weather was dull this material contained much more moisture than that in the second stack. An average sample was found to contain 26 per cent. of dry matter and 74 per cent. of moisture. Blowing was started at

11.15 a.m. on the 10th and was continued till 3.45 a.m. on the morning of the 11th. No further blowing was done on this stack during the 11th and 12th, as by that time it had been found that stack No. 1, which had not yet been taken down, was heating badly and a further attempt was made to dry it. When this had proved a failure and stack No. 1 was taken down, further blowing was given to stack No. 3 on the 13th. By 5 p.m. it was found that the stack was not yet dried, although it had been blown for 22 hours at an expenditure of 112 gallons of paraffin which cost £6, 15*s.* 4*d.* If we convert the weight of material used into hay containing 13 per cent. of moisture we will find that this stack would have yielded 2 tons 11 cwts. of such hay. As a matter of fact the material was not dry; a sample taken from near the boss in the centre where the material was driest was found to contain 80·6 per cent of dry matter and 19·4 per cent. of moisture, so that even in the centre the material was not well dried. The middle and outer portions were much wetter, and towards the outside the stack was still dripping wet and there was no evidence that the green material had been dried at all. The drying of this stack was therefore abandoned, and the stack was taken down and the material spread out and dried in the ordinary way. Before this was done the representatives of the patentees had left Craibstone, and shortly after they had gone it was discovered that stack No. 2, which till then had been supposed to be a success, was heating.

Tubes into which thermometers could be inserted were built into all the stacks at different points; they were placed at intervals round the stacks and at different levels. Regular readings of these thermometers were taken during the process of drying, and it was found that the temperature in the stacks varied very much from point to point. At certain points the temperature, especially during the earlier stages of drying, rose even higher than the temperature of the hot air which was being blown into the stack from the duct, while at the same time in other parts of the stack the temperature was very much lower than that of the duct air. Thus in stack No. 2 at 7.30 p.m. on July the 8th the duct temperature was 128° F. A thermometer 2½ ft. from the bottom of the stack on the south side registered 137° F., while one 2½ ft. from the bottom on the west side registered 77° F. One 4 ft. from the bottom on the east side stood at 113° F.; one 7 ft. from the bottom on the north-west side 75° F.; one 9 ft. from the bottom on the south-west 99° F.; one 10 ft. from the bottom on the north side 117° F. The unevenness of the temperature in different parts of the stack, which is illustrated by these figures, and which was found to exist all through the experiments, points to certain conclusions. If hot air were being driven equally through all parts of the stack, and if any fermentation were also taking place evenly, one would expect the temperature to be fairly even throughout the whole stack. While the stack was still damp one might expect the temperature to be high near the central boss from which the heated air was being distributed throughout the stack, and that it would gradually fall as one approached the outside. No such gradation of temperature from the inside to the outside was found,

but at about the same depth in the stack very different temperatures were found at different points. This indicates that air was not passing evenly through the stack, but that some parts were looser and allowed air to pass more freely than others. Those parts which gave the heated air freer passage would be more heated than the parts through which heated air had a difficulty in passing; such parts would also probably dry more quickly. Under practical conditions of stack building it is very difficult to pack the material with perfect evenness. Men have to trample in the hay as they build it up, and it is placed upon the stack by the fork in large bundles. Under such crude, practical conditions it is difficult to see how a mass of green succulent material can be packed so that an air current would distribute itself with perfect equality all through it. Further, as the grass and clover wither and dry, the stack shrinks considerably. It was found at Craibstone that the height of the stacks diminished 3 or 4 feet during the drying. Precautions were taken in building the stack to construct it so that it would settle down as evenly as possible round the boss, but in spite of such precautions the first stack quite obviously settled unevenly and became loose near the top, so that most of the heated air escaped around the top of the boss and did not pass through the body of the stack. While the drying was in progress the head of this stack was taken down and rebuilt in an attempt to overcome this difficulty In the case of the other two stacks, although no such obvious difficulty arose during the process of settling, it is difficult to be sure that the shrinkage did not cause the stacks to become opener in texture at certain points than at others.

The wind will also tend to cause unevenness of distribution of the heated air through the stack. It has already been pointed out that the second stack was quite dry on the east side, while it was found to be badly dried on other sides. During the experiments the wind was almost steadily from the west, and one of the reasons why the east side dried more quickly than the rest may have been that the natural air pressure caused the heated air to escape more by the east than by the west side of the stack.

It was found, as already stated, that certain parts of the stack sometimes registered a higher temperature than that of the hot air which was being blown in from the duct. This discrepancy cannot be accounted for by uneven distribution of the hot air, but must have been due to an abnormal rise of temperature caused by rapid fermentation of the materials of the stack itself. In previous experiments with cold air [1] it was found that stacks generally heated very unevenly, and that while parts might be quite cool other parts might rise to quite a high temperature. Such variations, which were produced by uneven fermentation in the stacks, were never completely explained, but some attempt was made to suggest an explanation by correlating them with the amount of carbon dioxide found in different parts of the stacks. Generally, where the temperature was high the percentage of carbon dioxide was

[1] "Artificial Drying of Crops in the Stack," by James Hendrick, *Trans. of the Highland and Agricultural Soc. of Scotland*, 1924, pp. 141-160, vol. xxxvi, 5th Series.

also high, and the measurements seemed to indicate that parts of the stack which were not quite stagnant but in which only a slow exchange of air was taking place rose to the highest temperatures. It is probable, in those cases in the 1925 experiments where it was found that the temperature of the stack rose locally above the temperature of the hot air which was being blown into it, that very little air current was passing; probably only sufficient fresh heated air was finding its way into such highly heated portions of the stacks to supply enough oxygen to maintain a high rate of fermentation.

TABLE III.

Analysis of Samples, Dry Matter of Grass and Hay.

	Stack No. 2.		Stack No. 3.		Hay made in ordinary way.
	Original Material	Hay from Stack.	Original Material.	Hay from Stack	
	Per cent	Per cent	Per cent	Per cent	Per cent
Ether Extract	2·92	2·50	2·01	1·97	1 72
*Albuminoids	9 37	9 10	8·88	9·25	9 94
Soluble Carbohydrates	52·87	52·71	53·80	51 80	46 82
Fibre	29·11	28 65	29·48	30 21	35 32
†Ash	5·73	7·04	5 83	6 77	6 20
	100·00	100·00	100 00	100 00	100 00
* Total Nitrogen	1·50	1 45	1 42	1 48	1 59
* Protein Nitrogen	1·27	1 26	1·21	1 16	1 42
† Including Siliceous Matter	0 47	1·38	0·68	0 98	0 68

In Tables II. and III. analyses are given of samples taken in connection with the experiments. No samples were taken from stack 1. In the case of stack 2, an average sample of the green material which was built into it was taken. This material, as stated above, had already been partly dried. When the stack was cut open at the east side an average sample of the hay in the sector which was removed from the stack was also taken. These are the first two analyses given in the tables. Table II. gives analyses of the samples, including moisture, while in Table III. analyses of the same materials are given, but calculated to the dry state. If we compare these analyses, especially as given in Table III., it will be seen that very little change in composition has taken place on drying in the case of stack 2. The hay obtained from this stack was evidently dried grass and clover, which had undergone little or no fermentation, and had lost little or none of its solid constituents after it was built into the stack. If this process were capable of producing hay such as that which was cut from the east side of stack No. 2, it might fairly claim to have a considerable advantage over the ordinary process of hay-making in our climate. In ordinary hay-making there is generally quite appreciable loss through fermentation, through the handling of the materials, and through washing by rain. In this case all such losses are absent, and the full value

of the green material built into the stack has been recovered in the hay.

Tables II. and III. also give analyses of the original green material which went into stack No. 3 and of a sample of hay taken from it. As already stated stack No. 3 was a failure, and was not nearly dried when it was opened; the centre portion, however, around the duct was found to be comparatively dry. An average sample was taken from this region, and it is the analysis of this imperfectly dried hay which is given in the tables. It will be seen that the analyses are not quite in such close agreement as in the case of the original and dried samples from stack No 2. In the case of No. 3, the stack stood longer during the process of drying, and at the end was still very wet and in a state of fermentation. It is probable that a little alteration had taken place in the composition of the dry material through fermentation; on the whole, however, the dry matter of the hay resembles fairly closely the dry matter of the original green material which went into the stack.

In Tables II. and III. the last analyses given is that of hay made in the ordinary way from the crop grown in the same field. The material was not quite the same as that which went into the experimental stacks, but it was grown on a neighbouring part of the same field, and the cutting was done about the same time as that of the material which went into stack No. 3. Table II. shows that the hay prepared on the field in the ordinary way was not very well dried. It has already been stated that the weather during the period of the experiment was unsettled and not good hay-making weather; nevertheless this hay, although it contained 20 per cent. of moisture, kept well in the stack and did not get mouldy. The composition of the dry matter of this hay given in Table III. shows that it did not differ greatly from the hay in stacks 2 and 3. It is rather more fibrous than the hay made by artificial drying and contains less "soluble carbohydrates." In this respect it is worse in quality than the artificially dried hay, and this may have been due in part to the method of making. We are not able, however, to conclude with certainty that this is the cause of the difference, as it may also have been due to the fact that the crop was from a different part of the field. It is also to be noted that the albuminoids in this sample are somewhat higher than those in the hay of stacks 2 and 3 In this respect it is rather better in quality.

One is not justified in drawing very definite conclusions from experiments made in one season only; so far as they go, however, the Craibstone results have not been satisfactory, and have shown that under certain conditions at any rate serious difficulties arise with the Oxford method of drying crops. The experiments may be looked upon as unsuccessful, first, because the stacks of hay were not dried. At Craibstone we grow a heavy crop which gives a large yield of hay; the mixture is always rich in clover and the clover is strong and succulent. Such material is, of course, difficult to dry. On the other hand, in the case of the second stack, the material was already partially dried on the field before the stack was built, and contained less than 60 per cent. of moisture when built into the stack. A second and more serious objection is, that in these experiments the consumption of paraffin was very great although the stacks were

not completely dried. Even had the drying been successful, the consumption of paraffin was so great that it would not have been economical.

A proof of the above paper was sent to the Institute of Agricultural Engineering at Oxford, and I am indebted to Mr. E. J. Robson, who, in the absence of Dr. Owen, sent certain comments and suggestions which have led me to amend certain passages in the paper. The staff at Oxford are naturally very disappointed with the results of the Craibstone experiments and Mr. Robson writes:—"As Dr. Owen pointed out in his letter to you of the 21st July there was no doubt that neither of the machines used at Craibstone was giving sufficiently good temperature results This was unfortunate for the success of the experiment, but had at any rate the effect of directing our attention to the question of so modifying the heating system as to enable us to count on a margin of spare on the right side. We have now substituted fuel oil for paraffin burners, with the result that we can readily obtain a temperature up to 190° F, and dry, at a cost per ton higher, it is true, than that quoted in the pamphlet issued by the Crop Drying Company which you quote, but at any rate so far as we can estimate at present, quite an economic cost."

PIG IMPROVEMENT.

I.—COMMERCIAL REQUIREMENTS.

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THE recently issued White Paper in which the agricultural policy of the present Government is announced shows clearly that the production of human food by means of livestock rather than through the agency of crops is believed by its authors to be the correct proceeding for this country. Whether one agrees or not with this belief, it is obvious that such assistance as the State is prepared to give to the farmer will follow the line of encouragement to animal husbandry. It is instructive, therefore, to examine the capacity of the different classes of animals on the farm to see which of them gives the best return to the farmer. The following figures from Henry and Morrison's "Feeds and Feeding' show the amount of human food produced by farm animals from 100 lbs. of digestible matter consumed.

Animal	Marketable product lbs.	Edible solids lbs.	Animal.	Marketable product lbs	Edible solids lbs.
Cow (Milk) ...	139·0	18·0	Poultry (Eggs) ...	19·6	5·1
Pig (Dressed) ...	25·0	15·6	Poultry (Dressed)	15·6	4·2
Cow (Cheese) ..	14·8	9·4	Lamb (Dressed)...	9·6	3·2
Calf (Dressed) ...	36·5	8·1	Steer (Dressed) ...	8·3	2·8
Cow (Butter) ...	6·4	5·4	Sheep (Dressed)...	7·0	2·6

It will be seen at once how both milk and pig flesh stand out above the other classes in economy of converting animal food into human food, and how far down in the scale come beef and mutton.

Now, as a business man, the farmer is not concerned with producing a large amount of food for home consumption, but only with the production of food which shows the greatest possible margin between the cost of production and the value of the product when sold, and it is obvious that both the sheep and the bullock consume a considerably cheaper form of digestible matter than does the pig. Even when this is taken into consideration, however, the pig does stand out as a very economical converter of animal into human food, and one of the main reasons for this is its extremely rapid growth There are still many people who do not fully appreciate the fact that every living animal requires food to supply the energy which is used up every day in the ordinary acts of breathing, moving and maintaining the circulation of the blood. From the nature of the case the food used in this way is absolutely and entirely unproductive to the farmer, and commercially it can only be looked on as an unremunerative gift to the animal. The longer an animal takes to produce the required amount of human food, the higher becomes the proportion of food wasted in supplying maintenance requirements.

It is the very rapid growth of the pig and the consequently very small proportion of maintenance food required that enables it to grow at the expense of such a small amount of food. Add to this the fact that a healthy sow under good management will produce and rear 16 piglings per year, and that the consumption of pig products in this country is so great that we imported £60,000,000 worth last year, and it is difficult to avoid the conclusion that pig-keeping ought to be one of the most profitable forms of animal husbandry. Such is the argument that has been repeated, perhaps one might almost say *ad nauseam*, in the agricultural press for a considerable number of years. Yet the pig is still the Cinderella of the farm animals; the import of fresh pork from the Low Countries increases rather than decreases, and co-operative bacon factories spring up all over the country only to fail before they have properly established themselves.

In order to reconcile these two sets of facts it is instructive to examine why pig keeping fails to maintain itself as one of the main branches of livestock husbandry. It is axiomatic that if any business is to improve either the receipts must go up or the costs must come down.

In pig farming it is common experience that receipts tend periodically to come down every three or four years during a "slump," caused either by a world overproduction or else by a more local overproduction of a type of carcase not required by the consumer. On the other hand costs may go up in the case of an individual farmer from one or more of the following causes. The price of the staple feeding stuffs may rise considerably above the average, labour may become very expensive, disease may cause almost complete loss, or the breeder may be developing a class of pig which grows too slowly and so wastes more food on

maintenance than is necessary. The feeding of improperly balanced rations will also raise the food bill beyond the economic limit.

The difficulty of high prices for feeding stuffs is connected with world agriculture and is consequently a very difficult problem, but it can be partly solved by applying the results of research in animal nutrition in such a way as to replace the expensive foods by combinations of cheaper articles which have been clearly proved to have the same approximate biological value. Animal nutrition too can be of perhaps even greater service in overcoming difficulties due to badly balanced rations.

The difficulty of expensive labour is always great, but can be overcome either by a change in management or, preferably, by the greater use of labour-saving machinery or other devices. The problem of disease is probably the most difficult one in swine husbandry to-day, and if swine fever, swine erysipelas and foot-and-mouth disease could be overcome, it is probably no exaggeration to say that the number of pigs in this country would soon be doubled. The problem is essentially one to be solved by the veterinary profession, but far too few people realise the necessity of a very high standard of hygiene where pigs are concerned with a view to avoiding the loss caused annually by intestinal worms, lice and mange, not to mention other minor ailments

The loss caused by reduction in the price of pig products, however, and the increase in cost due to the breeding of the wrong kind of pig can, in the opinion of the writer, both be overcome by concerted action on the part of both breeders and feeders, and an attempt will be made in this brief study to indicate the lines along which progress is likely to be achieved.

Historical.—A brief glance at the general lines of pig improvement will be of interest in showing us where we stand at present, and will perhaps also indicate the reasons why there is still so much to be done Before about 1870 it was not possible to keep meat in cold store, and so most of the bacon had to be cured in winter. Even then it was necessary to make it very salt indeed if it was to last at all into the summer. As very salt lean is even more unpleasant than very salt fat, it was natural that the class of pig required by the bacon curers should be a very fat one, and as curing was only carried out in the winter it followed that the pigs were mostly a year or more in age

When the introduction of cold storage made it possible not only to produce mild cured bacon, but also to produce it all the year round, bacon began to become a favourite breakfast dish in this country. But for breakfast no one wants a large expanse of fat, and it naturally followed that the pig in demand was one that was younger, carried more lean, and possessed a higher proportion of the typical frying parts than did the animal that had to be turned into salt pork. As it so happened this change in the type required coincided with the fact that Germany and some of the other central European states were refusing to import pigs from Denmark and Sweden These Scandinavian countries were quick to see the opportunity of a fresh outlet for their pigs, and commenced to send into this country bacon from their native breed of pig which was more or less developed to meet in Germany a rather

similar demand for a heavy pork pig to what had previously existed here.

Neither the British nor Danish pigs were at first really suitable for the new type of breakfast bacon, but according to Mr. Sanders Spencer (1) the breeders of Large Whites in this country were the first to improve their pigs by making them lighter in the head and shoulder, fuller in the hams, and by reducing the proportion of fat in the carcase. The result was so successful that the Danes very soon imported some breeding stock from the improved herds in order to breed boars for crossing on to their native pig, but they were so impressed with the value for bacon of the British pigs that they soon started and are continuing schemes for bringing their own pigs to the same high level.

The really interesting point for us, however, lies in this, that while the foreigner started with stock from this country and has gone on trying continually to improve it from a commercial point of view, the breeders of pigs in this country soon found other foreign markets, to supply which they sacrificed some bacon points of importance either for mere size or else for merely fancy points, according to the whim of the purchasers.

Although the first pig breed society was founded in 1884 and others have followed since whose aim was to improve the individual breeds, more attention than is warranted has been paid to developing points which cannot be proved to have any real commercial value. It is probable that this is due to the fact that in America and also in this country before the Great War the wealthy landed proprietors have taken a great interest in livestock from the sporting rather than from the business point of view. Owing to the very important social position which the landed proprietor occupies in the agriculture of this country, it has followed that his influence in breed societies and consequently on their breeding policy has been, and still is, predominant.

In Scandinavia and the Low Countries, as in the younger colonies and dominions, the breeding policy is controlled to a very much greater extent by the working farmer probably either because, being a land owner himself, he is more independent and accustomed to doing things for himself, or else because a landed aristocracy as we know it in this country is altogether absent.

Owing to the general depression which has followed the Great War, however, there has been an outcry against a slavish following of the pre-war showyard standards unless these could be definitely proved capable of producing an animal that was the cheapest to keep and would sell at the highest market price.. Many people, forgetting the prime importance of the capacity to produce and rear healthy offspring, clamoured to have the butcher's or bacon curer's ideal of a live pig made the standard of judgment at all the shows. But the general post-war experience has been that, even setting aside the important breeding points, the butchers and bacon curers themselves cannot be relied on to describe the external conformation of a live pig which is certain to conform with an ideal carcase after slaughter.

In confirmation of this it is only necessary to refer to the

second bacon pig competition held by the Scottish National Association of Pig Breeders in July and August 1925, the results of which competition are well known to every breeder and feeder of pigs in Scotland. The annual bacon pig show held by the St. Edmundsbury Co-operative Bacon Factory, Ltd., in May 1925 is another case in point. At this show the pigs were all judged alive according to the classes for different breeds and crosses and solely as bacon pigs. After all awards, including the supreme championship, had been awarded, the pigs were slaughtered and a separate competition took place in which each group of carcases was judged solely on its merits as bacon from the factory point of view. The following is the result of this carcase competition.

Carcase Award.			*Marks.*	*Award when alive.*
1st Prize.	Pen 10.	Class I.	85	Reserve (4th place) in Large White Class.
2nd Prize.	Pen 67.	Class VI.	83	3rd Prize in Class for any cross breed.
3rd Prize.	Pen 36.	Class V.	80	1st Prize in Class for first cross and supreme champion

Other examples could be produced, but these two very prominent cases show clearly that the judges were unable to pick out with any accuracy those live pigs which, when slaughtered, would produce the best bacon. As the judges were in both cases men prominent for their knowledge of pigs, the correct inference would appear to be that either there is no very exact correlation between external and internal conformation or that the most expert of human judges is not always capable of observing it.

Commercial Requirements—Having examined and criticised the methods so far adopted to produce an improved type of pig, it is of interest to start afresh by examining what really are the requirements of a pig which shall be profitable as a commercial animal without complicating the matter by thinking of what previous generations have made conventional Of the four principal products for which pigs are bred, namely pork, bacon, lard and bristles, only the first two are of real importance in this country. Because the imports of bacon and hams are nearly ten times the amount of imports of pork, it is generally believed that it is a bacon type of pig that should be produced here to resist foreign competition There is another school of thought which states that pork is cheaper to produce and more remunerative to sell in view of the proximity of good markets in the highly populated industrial districts, and that bacon production should be left to districts further afield than England and Scotland, where labour is cheaper and supplies of milk by-products more abundant. The writer believes, however, that there is sufficient evidence that a carcase that is ideal for bacon has not many faults from the pork point of view, but that a carcase that may be quite suitable for a pork butcher may be quite inadequate for turning into bacon. If one breeds solely for the pork market, there is always the danger that just when the pigs are the correct weight there is a "slump" in the market. With a good bacon type of pig it is always

possible to carry them on and trust to losing less by finishing them as bacon, because the variations in the curing trade are not usually quite so rapid as with fresh pork.

There is also the important consideration for any one who breeds his own piglings that where pigs are sold off young, as is the case in pork production, the proportion of breeding charges is distinctly higher. Where the pigs are carried on to bacon weight the cost of the necessary overhead charges of breeding stock are spread over a distinctly larger turnover, and to some extent this tends to lower the cost of production. For all of these reasons the following examination of commercial requirements will deal with what is known as the bacon type of pig.

As all successful business management is now based on records of costs, it is perhaps as well to begin by getting some idea of the relative importance of different items in the cost of producing a bacon pig. Table I. has been compiled to give the details of three sets of cost figures which have recently been before the public, and an estimate prepared some time ago by the writer for teaching purposes is also reproduced. In the case of Messrs. Marsh and Baxter's and Mr. James Ismay's figures for weaners the ratio of food to other costs was not given, but has been estimated as being approximately two to one.

TABLE I.

Cost of Producing Bacon Pig.

	Crowther.		Marsh and Baxter.		Ismay.		H.R.D.	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
Weaners—								
Food	23	7	26	8	16	8	19	2
Other Costs	2	7	13	4	8	4	9	7
Food...	97	3	86	0	58	4	86	2
Labour . . .	10	10	5	0	12	10	6	7
Other expenses less manurial value	...		7	10	...		...	
Management, depreciation, etc.	...		...		2	11	10	4
Bedding	...		...		0	5	...	
Total cost per pig	134	3	138	0	99	6	131	11
Percentage cost of food ...	90·0%		81·6%		75·3%		80·2%	

While each individual set of figures naturally varies slightly from the others, the outstanding fact remains that the cost of feeding amounts to approximately 80 per cent. of the total cost. In estimating his own list of costs the writer based his figure for cost of food on the assumption that the average amount of meal required to produce 1 lb. of live weight gain from weaning to slaughter was 4·7 lbs., an approximate figure based partly on results at the Cambridge University Farm and partly on the best available American figures. Now this means that for every tenth of 1 lb. of meal that can be saved in producing 1 lb. of live weight gain the farmer reduces his cost per pig by 1*s.* 10½*d.*, taking meal at a cost of about £11 per ton or 1¼*d.* per lb. In

order to reduce the total cost per pig by 6 per cent. or by 7*s.* 6*d.* (a figure we shall return to shortly) the consumption of meal has only got to be reduced from 4·7 lbs. to 4·3 lbs. per 1 lb. gain.

Now let us turn to the other side of the question and see how far the farmer can control the cash return from the finished product. In Table II. is set out a series of figures showing the approximate costs and returns from two pigs, No. 1 being entirely suitable for best Wiltshire bacon, and No. 2 being faulty from several points of view.

TABLE II.

Relation between Retail Bacon Price, Wholesale Bacon Price and Factory Price to the Farmer.

	Pig No. 1.	Pig No. 2.
Slaughter grade and price ...	Grade A. 19*s.* 6*d.* per Sc.	Grade 1. 18*s.* 6*d.* per Sc.
Carcase weight	150 lbs.	149 lbs
Bacon weight	112 lbs.	105½ lbs.
Loss in weight (carcase to smoked bacon)	38 lbs.	43½ lbs.
Percentage loss	25·5 %.	29·2 %.
Wholesale price of green bacon	147*s.* 6*d.* per cwt.	133*s.* per cwt.
Price of smoked bacon to grocer	157*s.* per cwt.	140*s.* 6*d.* per cwt.
Price per pig realised by factory (price per cwt. + offals at 6*d.* per lb. = $\frac{1}{5}$ths of loss in weight)	162*s.* 6*d.*	142*s.* 9*d.*
Gross factory profit	10·0 %.	2·6 %.

Retail Price.	Best Bacon.					Good Bacon.				
	Lbs	Per lb *s*	*d*	Amount *s*	*d.*	Lbs.	Per lb. *s.*	*d*	Amount *s*	*d*
Gammon hock	8·7	1	5¼	12	5½	6·8	1	3	8	6
Corner gammon	4·4	2	5¾	10	11	4·0	2	2	8	8
Long loin	3·2	2	1	6	7	3·2	1	10	5	10¼
Short back	4·3	2	5¾	10	8	4·8	2	2	10	0½
Rib back	8·8	2	1	19	9½	9·8	1	10	17	11½
Flank	2·6	1	0¼	2	8	3·1	0	11	2	10¼
Thin streaky	2·8	1	7¾	4	7	2·8	1	5¼	4	0¼
Thick streaky . ..	5·2	1	10	9	4½	5·1	1	7¾	8	4¾
Collar	7·3	1	2¾	9	0	6·4	1	0¾	6	9½
Fore hock	8·6	0	9¾	6	11½	6·6	0	8¼	4	6½
Total	55·9	.		93	2	52·7			78	4½
				s.	*d.*				*s*	*d.*
Realised per 112 lbs.				186	4	... ..			166	6
Cost per 112 lbs.				157	0	... ...			140	6
Gross retail profit				29	4 =15·7%.				26	0 = 15·7%.

The actual price of bacon will of course vary from day to day and from year to year, but the relation of factory price, wholesale price and retail price represents as nearly as possible the actual

commercial position. The figures for retail bacon are based on the tables in Nicholls' book on bacon (2) and have been scrutinised by a prominent firm of grocers. The factory prices and percentages were also examined by the manager of the bacon factory, and the actual weights of the carcases, bacon sides and cuts were taken by the writer himself.

The first point to notice is that at the factory in question (the St. Edmundsbury Co-operative Bacon Factory, Ltd., Suffolk), a bonus of 1*s.* for grade A pigs and of 6*d.* for grade B pigs is paid per score of 20 lbs. carcase over and above the ordinary price for medium quality or grade 1 pigs.

Many of the larger privately owned factories do not even make this difference between the best and the worst carcases received. This bonus means that on an eight score carcase the farmer gets 8*s.* more for one that is suitable than for a poor one, and, if the cost of producing that carcase has been 130*s.*, as suggested in Table I., then a good bacon carcase increases the farmer's cash returns by 6 per cent. Thus the same margin between cost of production and selling price is obtained either by reducing the food consumption per 1 lb. live weight gain by 0·4 lbs. of meal or by producing a carcase which will reach grade A standard.

But another very interesting figure can also be obtained from Table II. The wholesale price of green unsmoked bacon from the factory is 147*s.* 6*d.* per cwt. for best quality and only 133*s.* per cwt. for the poorer quality. This represents a difference of 14*s.* 6*d.* per cwt. or 2*s.* 7*d.* per score as compared with the 1*s.* per score paid to the farmer for the carcase. However only about 75 per cent. of the carcase is sold as bacon, and, as the value of the secondary offals is the same in both cases, the actual difference in value on the basis of the carcase weight is 1*s.* 11*d.* per score between the two qualities. If the factory could hand on this difference in value to the farmer it would be possible to increase the margin between production cost and selling price by 12 per cent. in favour of a first class carcase as against a poor one. Some at least of the co-operative factories would be willing to give the actual value for very good pigs, because it is obvious that in this way considerable economic pressure would be put in the scales against the poorly bred animals in favour of those with the correct conformations, but it is stated by all in the trade that as the exact grade of bacon, of which grades there are probably more than a dozen, is not known until some weeks after slaughter, and as the farmer demands his cheque within a few days, it is not possible to pay each supplier of pigs according to the actual returns of each individual side.

Whether this is really the case or not it is difficult to say, but it is more than obvious that by maintaining what is approximately a flat rate for all carcases, whether good or bad, there is a very distinct encouragement to the breeder to neglect carcase improvement, which at the best only returns him 50 per cent. of its inherent value, in favour of improvement in feeding methods and selection of those strains of pigs which inherit the capacity to make better use of their food than the average; a capacity which brings 100 per cent. of its value into the breeder's pocket.

Although carcase improvement, however, does not at the

present meet with its full due of commercial recognition, it is worth fuller consideration here for two reasons. In the first place, if bacon curers can be induced to pay more attention to the demands of the farmer, or if co-operative bacon factories can be organised so as to receive more support from breeders, it may yet be possible to increase the difference in the prices paid for good and bad carcases. And secondly, even if the full cash value of good conformation is not received at the time, it is still of great importance to the British breeder that the general standard of pigs should be improved because, although the retail grocer knows that there is nothing to equal British bacon at its best, he never really knows whether each individual bale is going to be "best" or "worst." It is this lack of standardisation which rightly meets with such distrust from the consumer in this country. The British housewife either does not want or else is unable to examine closely every pound of butter, cheese or bacon which she buys. She prefers something with a label such as she gets in "Danish" butter, which means that the commodity is the same every time she buys it. For many years it was no use telling her that New Zealand butter was just as good if not better. She knew that she could rely on always getting Danish butter the same It has taken some years to prove to her that New Zealand butter is now equally standarised. If the British farmer cannot or will not organise his pig industry so as to put on the market a product of a standard quality, it seems probable that Australasia with its tremendously large supplies of cheap milk by-products will soon add one more to the already large list of bacon competitors.

The parts of the carcase which require improvement will readily be seen from an examination of Table II.

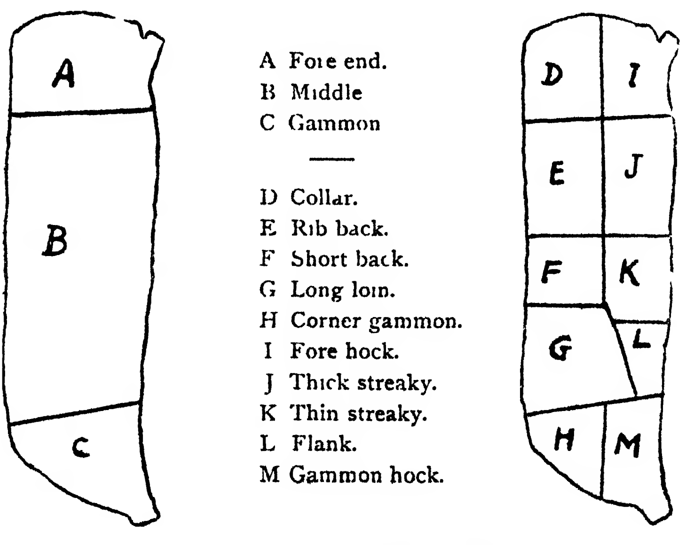

FIG. 1.—Distribution of Grocer's Cuts.

Fig. 1 shows how the bacon side is first of all divided into fore end, middle and gammon and then into the different cuts which

are given in Table II. If the prices for these cuts are averaged it will be seen that the prices of the three main divisions have the following relationship :—

Gammons	...	1s. 9½d. per lb.
Middles	...	2s. per lb.
Fore ends	.	1s. per lb.

Nothing further need be said about the importance of a light fore end, a long and deep "middle" and good hams. A few comments on the individual cuts, however, may not be out of place.

1. *Corner Gammon.*—Contains practically no bone, very little fat and a large amount of lean excellently suited for boiling.
2. *Middle Back.*—Produces "rashers" with well balanced lean and fat and which do not lose their shape on frying.
3. *Long Loin.*—Contains more bone than middle back, but also produces very good "rashers."
4. *Rib and Back*—Similar to Long Loin.
5. *Thick Streaky.*—Good mixture of lean and fat, but not of such good appearance when sliced as back.
6. *Thin Streaky.*—Similar to thick streaky, but if too thin it breaks up in frying
7. *Gammon Hock*—Good for boiling, but contains too much bone
8. *Collar.*—Space left after extracting shoulder blade bone spoils it for slicing.
9. *Flank*—Mostly too thin at one end to slice and too fat to boil at the other.
10. *Forehock*—Contains too much bone, skin and gristle, and muscles run in all directions Poorest cut.

From a consideration of all these points it is now possible to summarise the requirements of a breeding pig which is to yield a profit under commercial conditions These may be stated briefly to be as follows .—

A The breeding parents must *produce* pigs which yield a high proportion of the most popular cuts.

B. The offspring must be capable of making a given amount of growth for the smallest possible consumption of food.

C. Boars must be capable of producing large litters of healthy pigs, and sows in addition to this must have the capacity to bear and rear these large litters into healthy weaners at from eight to ten weeks old. This capacity will depend on the following :—

(1) Hereditary fecundity in boars and sows.

(2) In sows the possession of a large abdomen and wide pelvis.

(3) In sows a high milking capacity as indicated by:—

(i.) A strong, capacious digestive system.

(ii.) An adequate number (12-14) of *well-placed* teats.

(iii.) The capacity to convert food into milk and not into flesh.
(iv.) A docile temper.

An attempt has been made to show that present showyard methods do not achieve as much progress towards the ideal attainment of these requirements as modern scientific information suggests is possible, and the next article will deal with the way in which this problem is being tackled by our competitors and a suggestion as to how this competition might be countered.

The writer is indebted to the management of the St. Edmundsbury Co-operative Bacon Factory for facilities to examine and weigh the sides of bacon referred to in Table II.

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THE BIOLOGIST ON THE FARM.—No. XXI.

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Bumble-Bees.—There are many different species of humble-bee in Britain, but among the hardier, that appear earliest in the year, are the great earth bee, *Bombus terrestris*, and the early nesting bee, *Bombus pratorum*. Of last year's large family or community the sole survivors are the young queens who have remained in lethargy all through the winter in a hole beneath the ground or in a mossy bank. When a queen is aroused by the spring sunshine from her strange state of inertness, which we dare not call either sleep or hibernation, she makes for early flowers such as the willow catkins, the flowering currant and the purple dead nettle. If the afternoon is still too chilly she goes back to bed, and may remain quiet for days before she gives the outer world another trial. When the spring really comes she begins to make a summer nest, often choosing the field vole's deserted burrow. On a minute mound of pollen-paste, surmounted with a parapet of wax, she lays some eggs and broods over them for about three weeks. She always has her head towards a honey-pot—a sort of widow's cruse—from which she can sip during the chilly night or when the weather is bad. By short foraging excursions, which from time to time interrupt her brooding during the day, she keeps the honey-pot replenished, and it supplies the first meals for the young bees when they struggle out of their cells. After the emergence of the first brood of workers, the queen becomes entirely maternal. Brood succeeds brood, each lasting for about a month, and numbers gradually mount up. But the prosperity of summer does not last long; supplies begin to fall off, the queen becomes tired, drones and young queens appear. Numbers decrease, the stores are used

up, the old queen, bald and weary, has but a small retinue, and soon all are gone save the young queens who have been fertilised by the short-lived drones. On these young queens, who seek out snug winter quarters, the continuance of the bumble-bees depends.

Health and Sunburning.—From racial experience for centuries and individual experience in every lifetime, there has been for a long time no doubt as to the health-giving value of light. But, as everyone knows, the analysis of this value has made great progress in recent years, and it has been shown that much is due to the ultra-violet rays which we cannot see, though ants can. It has been shown that these ultra-violet rays have a subtle action on the chemical routine (or metabolism) of the body, especially as regards lime, and may act as a tonic on growth But the effect seems to be very intricate. Thus it has been shown by Colebrook, Hill and Eidinow that when the skin of an animal or a man is exposed to sources of ultra-violet rays, the power of the blood to kill bacteria is greatly increased (even by 65 per cent. in the rabbit and 17 per cent. in man), when estimated in a test tube at any rate Eidinow has recently shown that this microbe-killing power of the blood is evoked only when the rays produce a reddening of the skin The rays derived from a mercury vapour lamp, a carbon arc, and the sun's rays are equally efficient, but the exposure must not be excessive, and there is no good result in cases of acute bacterial infection. How the germicidal power of the blood is increased remains uncertain, but it depends on some changes in the blood-corpuscles.

Standing the Winter.—The winter is more or less over in the North of Scotland, but there will soon be another. There are some farms where each winter is the severest that there has been for 53 years, so the subject of this note should be apposite there What we have to say is very interesting, that if you get plenty of light you can do with less heat. In one of the reptile houses at the "Zoo" in London they proved this last winter for Iguana lizards In previous years these big lizards never survived the winter, though they were kept warm They always lost colour and appetite moped and died. But last winter the experiment was made of irradiating their environment with powerful electric lights in globes transparent to ultra-violet rays. The result was that the lizards kept their colour and their appetite, exhibited an activity never before seen in this country, and displayed vigorous health and spirits. The same result rewarded the irradiation of baboons and monkeys. Warm floors and abundant light (including ultra-violet rays) served to keep them in good fettle and enabled them to breathe cold air, which also makes for health. All this confirms the growing belief in the value of more light.

The Apprenticeship of the Worker Bee.—Natural History becomes more and more precise, and as observation deepens so does the wonder. By marking worker bees in an observation hive Rosch has been able to follow their apprenticeship and their gradual promotion, so to speak, from one kind of duty to another in the course of their short life of a month or six weeks. The newly emerged workers are turned to the task of preparing and cleaning wax cells in which the queen will lay eggs. After a few

days they pass, or are promoted, to the status of nurses, watching over the young bees in their cells. At first they tend only the older larvæ, supplying them with pollen and honey, but later they are trusted with the "babies" of the hive, which require a nutritious fluid secreted by the worker bee from glands which begin to function at this time, about the tenth day of adult life. When the worker is a fortnight old, more or less, she leaves the nursery to spend a week in the general service of the hive, cleaning away refuse, distributing and storing food and so on. Trial flights in the open may also be made, but on these first attempts no pollen or nectar is collected. Finally, at the age of about three weeks, each worker is assigned the last of its indoor tasks, that of acting as guardian at the gate, preventing the entry of strange bees or other insects. When this task is done the worker bee devotes all its remaining life and strength to the arduous work of collecting nectar and pollen from the flowers. Here, too, as Frisch has shown, there is much division of labour, for the bee does not flit heedlessly from flower to flower, but, once given over to tapping one profitable and abundant species of flower, may keep to this for the whole of its outdoor life without ever entering another kind of blossom! But what is new in Rösch's study is the definite proof of a regular succession of tasks in the worker bee's life. The science of animal behaviour is growing apace.

The Chromosomes of Cereals.—In each kind of many-celled organism, whether plant or animal, the nucleus or kernel of each of the multitude of cells building up the body has a definite number of rods or chromosomes which carry the hereditary factors or some of them. In all the cells of the body there is this particular number (the diploid number), but in the ripe egg-cell and male cell the number is reduced to half the normal (the haploid number). Man's number is 48, and as the same number occurs in some snails and plantains, it is evident that there cannot be much significance in what the particular number is. What is important is the fact that the normal number, whatever it may be, is adhered to throughout all the cells of the body. Growth involves cell-multiplication, and whenever a body cell divides into two, there is an adherence to the normal number. The lowest number is two, for the threadworm of the horse; one of the high numbers is 60, for the horse itself.

One of the recent discoveries in regard to chromosomes is that their number may show an orderly arithmetical progression in a series of related species. That is to say, in a series of species belonging, for instance, to the genus rose, some species have 14, others 28 and others 42, showing a regular multiplication. This is of interest in agricultural plant-breeding, and is actually leading already to practical results. In wheat and oats the haploid number is seven, and there are species with 14, 28 and 42 chromosomes—so-called diploid, tetraploid and hexaploid species. The same ruling number—the sacred number seven—is found in rye and barley, but species or races with multiples have not yet been found. The subject has been recently investigated by K. V. Stolze, who favours the view that the transition from one species to another in a (polyploid) series has been brought about by a transverse, not longitudinal, splitting of the chromosomes. We

cannot pursue the subject, but it is interesting to find a numerical test for species.

Homing in Horses.—If someone with time, patience and good-humoured scepticism would collect data in regard to homing in horses, the result would be, in proportion to its critical sifting, a valuable contribution to the young science of animal behaviour. But some experimental work would also be necessary. The homing powers of carrier pigeons are familiar, and it has been proved up to the hilt that migratory birds, such as swallows and storks, may return from their winter quarters in Africa to the northern farm where they were born the previous summer. The homing power has been carefully studied in two species of tern or sea-swallow, and it has been proved that a percentage of the birds experimented with can return to their nests from a distance of 800 miles, having been transported in closed baskets on board ship into waters that they had never before visited. The facts. are certain, but how the homing power works we do not know.

From a limited distance some of the ants can find their way home successfully, and the balance of evidence points to the conclusion that in many cases at least the little people serve an apprenticeship to their environment. They register various kinds of impressions—of smell, touch and sight—and they sometimes give evidence of "muscular memory," that is to say of having somehow registered their movements so that they can retrace their steps. To some extent the same may be said of hive-bees; and it is interesting to recall the fact that when the queen humble-bee has found a suitable nesting-place, she is careful to take her bearings so that she can find her way back after a flight. We are coming to the horse by and by, but we may be allowed to quote an instructive passage from Mr. F. W. L. Sladen's "Humble Bee." The queen crawls round the entrance and poises herself towards it as she takes wing. "Then she rises slowly, and taking careful notice of all the surroundings, describes a series of circles, each one larger and swifter than the last. So doing she disappears, but soon she returns and without much difficulty rediscovers the entrance. Similar but less elaborate evolutions are made at the second and third departures from the nest, and soon her lesson has been learnt so well that her coming and going are straight and swift." We have cited this passage from an experienced observer, because it suggests that the homing power in insects is different from that in birds and mammals. The terns were taken far away into unknown seas. A cat taken by train from Fife to Ayrshire may find its way home. In such cases, and they are typical, there is no question of mastering the topography.

Some good data for horses have been recently forthcoming, and those who are interested will find a number of letters on the subject in *The Observer* for March 21st. It seems that a two-year-old horse taken to a new place at some distance late in the evening, in part in darkness, found its way home next morning. It seems that a horse can find its way home in wild Australian country from a distance of 50 miles. There is abundant evidence that in thick darkness or in fog some horses may be trusted to find their way home. Sometimes they have proved to be right when

their master thought they were quite wrong. In estimating the data there should be in the first instance a ruling out of all cases of habituation, for this complicates the issue. Moreover every driver knows that horses have a keen topographical memory. They register difficulties and peculiarities of a road, even when their experience of it is very slender. The most interesting data relate to homing from a new place at a considerable distance, and it would be interesting to find out how many tentatives or even mistakes the clever creature makes. It would be of great interest to make the crucial experiment of transporting the animal in a horse-box during the night, and then observing if it made for home.

Plumage and Gonads.—It has been shown that the removal of the ovary from some kinds of ducks induces the development of the typical drake plumage. A hormone from the ovary exerts an inhibitory influence on the masculine plumage characters which are latent in the female bird, on the removal of the ovary the masculine characters assert themselves, being no longer kept in check What we have referred to is the result of an old experiment by Goodale (1916), but the matter turns out to be more complicated than was at first supposed. We shall return to this on another occasion, but we wish just now to call attention to an interesting study by A W. Greenwood and F. A. E Crew. Into a brown leghorn hen, ovariotomised when four days old, the testes of a brother bird were implanted. Under the influence of the hormone from this active testicular tissue thus introduced the hen became cock-feathered This was what might have been expected, but after a general moult her plumage became that of a hen This was a puzzling result Post-mortem examination revealed a small fragment of degenerate ovarian tissue and a large amount of testicular tissue that had developed from the grafts. As the result is not interpretable in terms of hormones, the experimenters suggest that the greatly increased amount of testicular tissue had exerted demands on the body equivalent to those of an active ovary. This led to the development of the hen plumage This is in accord with the general metabolic theory of sex as suggested long ago by Geddes and Thomson in "The Evolution of Sex" (1889)

THE COMPOSITION OF SWEDES.[1]

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THE composition of home-grown crops, as compared with artificially prepared feeding stuffs, is a subject which has received little attention until comparatively recently. Under the Fertilisers and Feeding Stuffs Act the composition of all artificially prepared feeding stuffs must be guaranteed by the vendor, but home-grown crops are still sold largely on the result of a qualitative and

[1] A report on the work of the Committee appointed to investigate the composition of swedes

superficial examination of their external appearance. The same practice has obtained in the awarding of prizes for home-grown crops at agricultural shows, and it is only within the last few years, and in a limited number of cases, that anything more than the appearance of a crop has been used as a guide to its excellence. The question naturally arises how far these conventional methods, in the application of which buyers and sellers doubtless become very skilled, afford a real estimate of the value of the crop being judged. The results of certain field experiments, of an accurate kind, recently carried out certainly suggest that some of the conventional methods for estimating quality are not above suspicion, and that there is need for a scientific investigation into the whole subject.

The question of what the quality of a feeding stuff depends upon raises problems of considerable difficulty. While it is not difficult to say, by the conventional methods of analysis, which of two samples of linseed cake is the better, it is a more difficult matter to estimate the relative merits of two different kinds of feeding stuffs by the methods of analysis now available. It is not easy to connect the elusive property which we term "quality" with any factor which is capable of exact and rapid determination by analysis. The difficulty of the problem varies, of course, in different cases; with sugar beet, for example, the problem was at any rate fairly definite, i.e. to develop a variety with a high sugar content capable of giving a good yield per acre.

The particular investigation to be described in this paper arose out of the work on swedes and turnips commenced at the Plant Registration Station at East Craigs of the Board of Agriculture for Scotland, when on the advice of the Standing Committee of the Station some sixty samples of swede and turnip seed supplied by representative merchants were sown in 1921. The object of this investigation was to try to classify the roots according to their botanical characteristics and habits of growth. While little difficulty was found in classifying the plants into a limited number of groups, the Committee felt that it was desirable that the enquiry should be extended with the object of getting additional information on the relation between the composition and the feeding value of the roots. The Committee of the Station, therefore, with the approval of the Board of Agriculture for Scotland, arranged for the setting up of a Committee to carry out a systematic investigation of the problem and the following Scientific Sub-Committee was appointed:—Sir David Wilson, Bart., D.Sc. (*Convener*), Professor Hendrick and Dr. Orr (Aberdeen), Dr. Lauder (Edinburgh), Dr. Berry (Glasgow), Mr. David Bell (of Messrs. D. Bell & Co., Leith), Mr. Thomas Anderson, Director of the Seed Testing Station, and Mr. Montagu Drummond, Director of the Plant Breeding Station at East Craigs. Mr. B. A. Hyslop of the Board of Agriculture for Scotland acted as Secretary to the Committee. Mr. Godden, of the Rowett Institute, served in place of Dr. Orr, and Mr. Robb was later appointed to succeed Professor Drummond.

The first meeting of this Sub-Committee was held in November 1922, when the general plan of the work was discussed. It was

agreed that a certain number of varieties of swedes should be grown at Aberdeen, Edinburgh and Glasgow (Kilmarnock), and then analysed, the seed being obtained from the same sources in each case. General plans of analysis were considered, and it was remitted to the chemists concerned (the Chemical Committee) to discuss the analytical methods in detail.

Both these Committees have met regularly since then, and while the investigation is far from being completed, a stage has been reached when some account of the results obtained will probably be of interest to the agricultural public.

The Chemical Committee first considered the investigations which had already been carried out by previous workers in this country. In 1905 Collins (*Journal Agricultural Science*, I, 89) gave the results of an extended investigation into the variation in the chemical composition of the swede. A little later in the same year Wood and Berry (*Journal Agricultural Science*, I, 176) published the results of an elaborate investigation into the variation in the chemical composition of mangels. Both these papers are mostly concerned with the amount of dry matter in the roots. In the following year Hendrick (*Transactions Highland and Agricultural Society*, XVIII (1906), 281) gave a review of the work already done and described additional investigations which he had carried out. Hendrick suggested that the determination of the ratio of soluble to insoluble matter in the solid matter of the root might be of value in the selection of "seed mothers," and he and Greig carried out further experiments on these lines.

Coming to the work of the Sub-Committee, it was decided first of all to carry out more complete analysis of the roots grown at all three centres than had been attempted by previous workers. In the crop of 1923-24, for example, the following estimations were made—(1) total solids; (2) insoluble solids; (3) soluble solids; (4) total nitrogen; (5) "albuminoid nitrogen"; (6) mineral matter, (7) lime; (8) phosphoric acid; (9) density of juice; (10) total solids in juice; (11) sugar in juice. The weight in each case of 100 roots and the yield per acre were also determined.

In addition Mr. Godden, at the Rowett Research Institute, Aberdeen, carried out a more detailed analysis of the mineral matter of a limited number of varieties; he also investigated the effect of manuring on the composition of the mineral matter of the roots, but no direct relation could be inferred from the results. The effect of sampling the same variety at different dates was also determined.

On reviewing the results of the work at the end of season 1923-24 the Committee was of the opinion that it was desirable to make a further critical examination of methods of estimating the dry matter in the roots; it was convinced that an accurate knowledge of the percentage of dry matter was of great importance, and it was not entirely satisfied with the methods hitherto in use. The work during the winter 1924-25 was therefore confined to this one point, and the effect of drying the roots at different temperatures and in currents of inert gases such as nitrogen and carbon dioxide, as compared with air, were duly investigated and much valuable information has been obtained, with the result that

it is believed that the estimation of the dry matter is now on a satisfactory basis.

In a paper of this kind it would obviously be out of place to consider in detail the results of the various special investigations into analytical methods described above; attention will therefore be confined to one or two of the more important points which have emerged, and to the proposals of the Sub-Committee for continuing the investigation.

The following varieties were grown at each centre:—Bronze top type (Globe), Bronze tankard, Best of All, Inverquhomery type, Kinaldie type, Bangholm, Superlative, Monarch, X'L All type, Magnum Bonum These are typical of the best varieties on the market. The seed was obtained from the same source in each case, and the manurial and cultural treatment was, as far as possible, identical at the three centres The sampling was done by boring cores diagonally through the roots from the shoulder, 50 to 100 cores being taken from alternate roots in the drills in each variety. The roots were sampled not on identical dates, but at the appropriate time according to season in each district. The yield per acre was also determined, but, as only single plots of each variety were grown, no accurate comparison of yields can be based on the re ults obtained; so far as they go, they tend to suggest that the varieties with a high percentage of dry matter give a smaller yield per acre

An examination of the figures obtained shows the existence of two separate kinds of differences, viz —(1) Those due to locality and climate, (2) those due to variety.

(1) *Differences due to locality* —Speaking generally, it may be said that the roots grown at Aberdeen show the highest and those grown at Kilmarnock the lowest percentage of dry matter, the roots grown at Edinburgh being intermediate in dry matter content between Aberdeen and Kilmarnock. The only exception to this is that in 1923-24 roots were grown at Edinburgh at two different farms, viz. East Craigs, Corstorphine, and at the College Farm at Boghall, the elevation of the latter being 600-800 feet, and much higher than East Craigs. The dry matter content of the roots grown at Boghall was much higher than that of those grown at East Craigs, and corresponded rather with the composition of the roots grown at Aberdeen; the comparison will be repeated in 1926 to see if the difference is a constant one.

In fig 1 the average percentage of dry matter for 1923-4 of all the varieties at each centre is shown; it varies from 14 10 per cent at Aberdeen to 10 59 per cent. at Edinburgh and 10 05 per cent. at Glasgow. The dry matter is further divided in insoluble and soluble solids, and the amount of sugar in the soluble solids is shown. It will be seen from the diagram that the amount of insoluble solids is roughly the same at the three centres, viz,—2·93, 2 87, and 3 10 per cent., and that the variation is in the amount of soluble solids, viz.:—11·17, 7 72, and 6 95 per cent. The same relative order as was shown in the dry matter is shown in the amount of sugar, viz.:—9·75 per cent. at Aberdeen, 6·92 per cent, at Edinburgh, and 5·78 per cent. at Glasgow. Roots grown in the north-east of Scotland are generally supposed to be more nutritious

than those grown in the south and west. and the above figures lend support to this view.

(2) *Differences due to variety.*—When the varieties are arranged in order of their dry matter content, it is found that the order is the same, with trifling exceptions, at all the centres, and also the same for different years The varieties may therefore be divided into the following groups, varieties in the same group having no significant differences between them, a difference amounting to

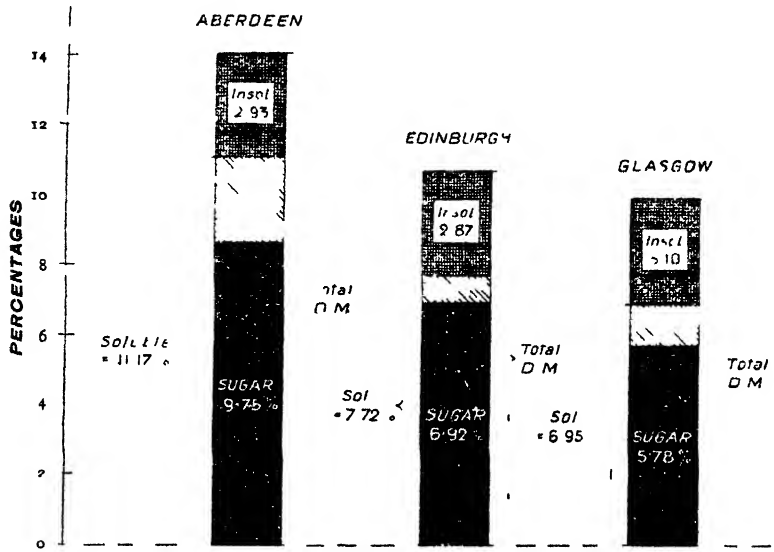

FIG 1

AVERAGE PERCENTAGES (over all Varieties) for the Season 1923 4 of Total Dry Matter (D.M), Insoluble Solids, Soluble Solids, and Sugar for the Three Different Centres

three times or more of the experimental error has been taken as a significant difference —

Group I	1st	Kinaldie type.
	2nd.	Bangholm type.
	3rd	Inverquhomery type.
„ II	4th.	Monarch
	5th.	Best of All.
„ III.	6th	Bronze Top (Globe)
	7th	X'L All type.
„ IV.	8th.	Bronze Tankard.
	9th.	Superlative.

The differences in dry matter between certain of the varieties is shown graphically in fig 2, the Superlative type, which has on the whole the lowest dry matter content, is taken as zero, and the dry matter of the four varieties, Kinaldie, Monarch, X'L All and Bronze Tankard (i e. one variety from each of the four groups above), plotted against this The dry matter differences between

the Superlative type (always put=0) and each of the four other varieties are set out for the various centres and years and the points so obtained joined up for each variety. The figures obtained show that these varieties differ both from Superlative and among themselves in a fairly regular and constant manner. It will be noted that the differences between the varieties is greatest at Aberdeen and least at Glasgow, where the differences between the varieties is rather insignificant; Edinburgh occupies an intermediate position.

Composition of the dry matter increase from the lowest (Bronze Tankard type) to the highest (Kinaldie), fig 3.—The average composition for 1923-24 of each variety for the three centres was first calculated, and then the composition of the increase from Bronze Tankard type to Kinaldie; the increase amounts to

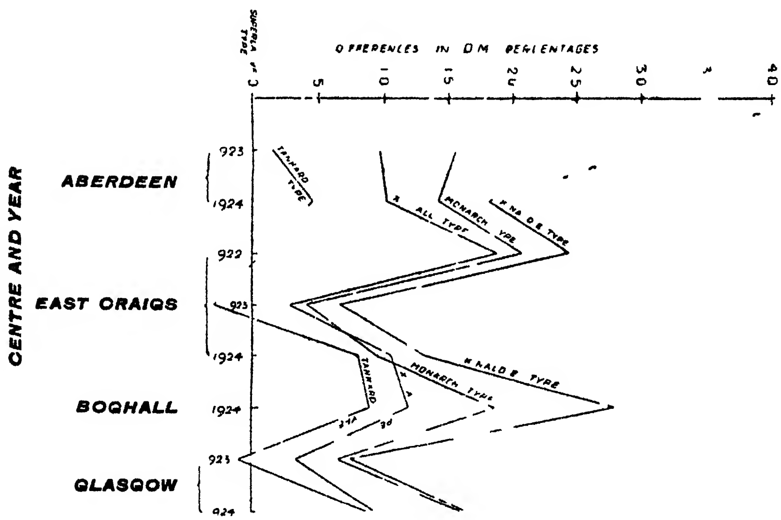

FIG. 2.
DIFFERENCES IN DRY MATTER (D M)

TABLE showing Differences between Superlative Type ("Picton'), taken as zero, and each of the Varieties Named for the Centre and Year mentioned.

	"KINALDIE" Type.	Monarch Type · "STIRLING CASTLE."	"X L ALL."	Tankard Type: "LEIGHTON'S BRONZE TOP."
ABERDEEN.				
1923 . .	+4·38	+1·56	+0 97	+0 15
1924 . .	+1·82	+1·43	+1·03	+0·47
EDINBURGH.				
East Craigs.				
1922 . .	+2·46	+2·08	+1·84	...
1923 . .	+0 67	+0·41	+0·28	−0 30
1924 . .	+1·30	+0·94	+1·05	+0 60
Boghall.				
1924 . .	+2·80	+1·87	+1·20	+0·90
GLASGOW.				
1923 . .	+0·76	+0·66	+0·35	−0·10
1924 . .	+1·66	+1·64	+0·93	+0·84

2·02 per cent. (Bronze Tankard type = 10·65; Kinaldie = 12·67 per cent.), and of this, approximately half goes to the soluble solids (1·07 per cent.) and half (0·95 per cent.) to the insoluble solids; but while the soluble and insoluble solids are increased by roughly equal amounts, the former is increased by 12 per cent., while the latter is increased by 43 per cent. That is, the increase in solid matter of Kinaldie as compared with the Bronze Tankard type is much more in the insoluble than in the soluble matter. This is in striking contrast to the differences due to locality, where the

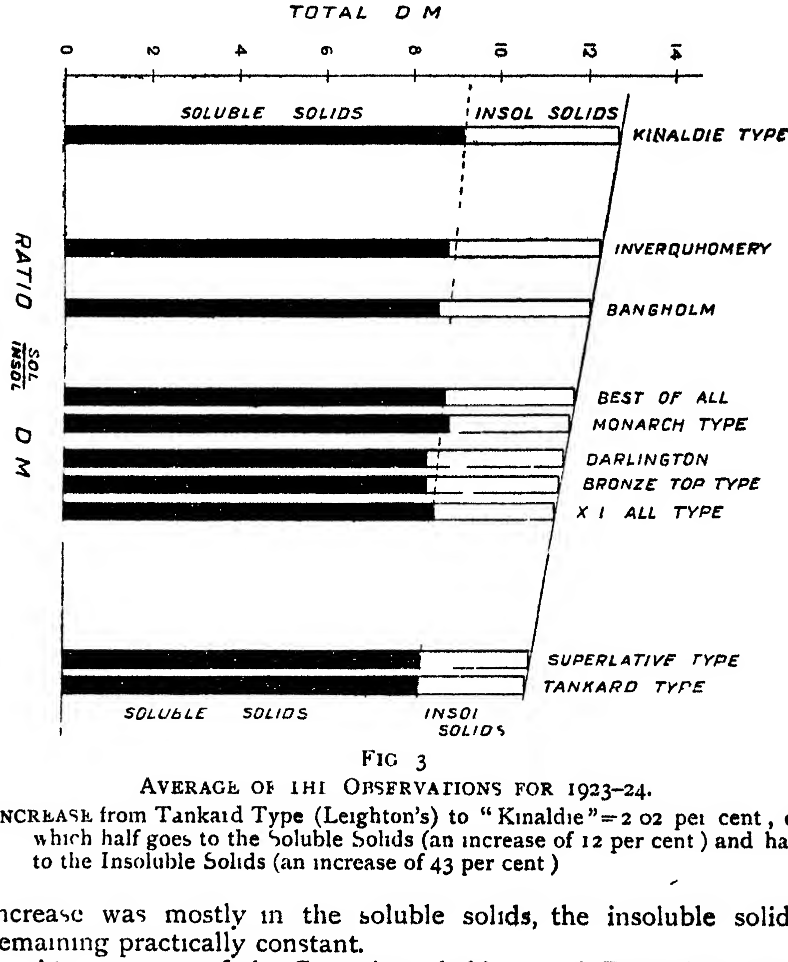

FIG 3

AVERAGE OF THE OBSERVATIONS FOR 1923–24.

INCREASE from Tankard Type (Leighton's) to "Kinaldie" = 2 02 per cent, of which half goes to the Soluble Solids (an increase of 12 per cent) and half to the Insoluble Solids (an increase of 43 per cent)

increase was mostly in the soluble solids, the insoluble solids remaining practically constant.

At a meeting of the Committee held on 15th December, 1925, it was agreed to continue the investigation into the composition of the dry matter, and to determine the percentages of sugar, protein and non-protein nitrogen ("albuminoids" and "amides"), the mineral matter, and the lime, in the roots grown at the different centres Further investigations into methods of determining the dry matter were also agreed upon.

It was also decided that, if possible, a sheep and cattle feeding experiment should be carried out at each of the three centres with

the crop of 1926-7,—the varieties showing the highest (Kinaldie) and lowest (Superlative type) percentages of dry matter being compared as to their feeding value.

The writer desires to express his indebtedness to Mr. D. S. Gracie, B Sc., of the Edinburgh and East of Scotland College of Agriculture, for his assistance with the large amount of calculations involved.

CASEIN AND THE DAIRY INDUSTRY.[1]

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CASEIN is a constituent of milk and it is well known in connection with cheese-making From the earliest of time it has played an important part in the dietary of the human race. It forms the principal flesh-forming substance of the food of the child and of the young animal. Its high nutritive value, and the fact that its presence makes it possible to convert milk into cheese and whey, are properties which have created for it a world-wide demand. Its property of dissolving in alkaline liquids forming glue has long been known. Its use as glue can be traced back to the time of the early Egyptians, and in the middle ages carpenters used a casein glue for panelling. The adaptation of this property on an extensive scale to technical purposes has been neglected until within comparatively recent years; now its uses in the arts and industries are almost legion The demand for casein, therefore, arises mainly from two widely different properties, namely: (*a*) its function as a nitrogenous food stuff and (*b*) its manifold industrial applications.

Regarding its source, casein constitutes about 80 per cent. of the proteins of cows' milk. Its amount and quantitative relationship to the other proteins in milk are affected by the individuality of the cow, the breed, the stage of lactation, the food, the season, etc. For illustration, in the milk of individual cows the casein is found to vary from a minimum of 1·8 to a maximum of 6·3 per cent.; in the mixed milk from a herd of cows the variation is less, namely, from between 2·0 and 3·0 per cent. The milk from different breeds shows a variation such as follows:—

	Per cent. Casein.	*Total Protein*	*Total Protein. per cent. Casein.*
Holstein ...	2·20	2·84	77·5
Ayrshire ...	2·40	3·07	78·1
Shorthorn ...	2·79	3·43	81·3
Devon	3·16	3·93	80·4
Guernsey ...	2·91	3·56	81·7
Jersey	3·03	3·68	82·8

As between the milk in the early compared with the late stages of lactation, there is commonly an increase of about 0·5 per cent.

[1] These notes are abstracted from a paper on "Casein, its Properties and Uses," read at a meeting of the Andersonian Chemistry Society, Glasgow, on 15th January 1926.

in favour of the latter. In time of drought, when cows are wholly dependent upon pasturage, the casein is found to decrease appreciably. As regards milk from other sources, human milk contains a little over 1 per cent. of casein, the milk of the goat 3·2 per cent., of the ewe 5·0 per cent., of the mare 1 24 per cent. and of the ass 0 67 per cent.

For a long time casein was believed to be in solution in milk; the view held now is that it exists in milk in a state of pseudo solution, that is in the form of very minute gelatinous particles suspended in the milk serum. The addition of acids, rennet and many other reagents to milk causes these minute particles to aggregate and separate out in a flocculent condition as curd. Rennet curd differs from acid curd principally in the amount of ash The former usually sells at a higher price and is more suitable for making into casein plastics; the latter is more suitable for making glue, adhesives, etc. Analysis of two kinds of industrial casein made from separated milk is shown below

	Rennet Casein per cent.	*Acid Casein per cent.*
Water .	1·0–10·8	7·1 – 8·5
Fat	0·1 – 0·55	0·08 – 0·33
Ash	5 0 – 8·85	2·9 – 6·03
Casein .	94 8–81·6	89·8 –84·12

As a rule the rennet curd contains about 8 per cent of ash; the acid curd between 3 and 4 per cent, depending upon the nature of the acid employed and the amount of washing The more acid used in precipitating the curd, the lower the ash content, which is also lowered by washing.

Separated milk is used almost entirely for the manufacture of casein. Buttermilk, when available in quantity, is sometimes used, and the soya bean is also under investigation as a source of protein to be used as a substitute for milk casein.

In Scotland, where live stock raising is such an important industry, it should be possible to utilise separated milk more profitably for feeding than for the manufacture of casein. But in the spring and summer months more separated milk is produced in cream and butter making than can be conveniently disposed of for feeding purposes. In creameries where such a condition exists, the question of the manufacture of casein is one which should receive careful consideration. It is computed that over 11,000,000 gallons of separated milk are produced annually in this country, the greater part of which is consumed in stock feeding A small portion is utilised in the baking industry and some is made into skim milk cheese, evaporated, condensed and powdered milk.

There are many methods of preparing casein from separated milk, but for its preparation on a commercial scale the methods are usually restricted to four, namely:—

1. Curdling by natural souring.
2. " the action of rennet.
3. " the addition of mineral or organic acids.
4. " electricity.

Details of these methods are available.

Green or wet casein, pressed and properly prepared, keeps fresh long enough to allow of its conveyance to a central factory situated within a reasonable distance for drying. This means that the supplies of curd need not necessarily all come from the factory in which the drying and preparation of the commercial casein is carried out.

The annual consumption of casein in milk and cheese in Great Britain is computed to be about 421,000,000 lbs., made up as follows:—

	Scotland.	*England and Wales.*	*Great Britain*
Milk	45,965,000	267,919,000	313,885,000
Cheese ...	5,280,000	19,360,000	24,640,000
Imported Cheese	...	...	82,700,000
Total ...	51,245,000	287,279,000	421,225,000

The figures are indicative of the importance which must be attached to casein as a food stuff. An index to its value for technical purposes is shown by imports of casein into Great Britain and Ireland for several years, given below:—

Imports of Casein into Great Britain and Ireland.

	1923 Weight.	1923 Price.	1923 Total Value	1921.	1922.	1923.
	lbs	per lb	£	per cent	per cent	per cent
France	3,489,000	$8\frac{1}{4}d$	110,007	13·7	27 7	33·8
Argentine Republic ...	1,807,000	$7\frac{1}{2}d.$	56,984	23·8	23·3	17·5
Netherlands	15,680	$8d.$	528	0 2	1·5	0·2
Norway	...	..	...	2·7	0·2	...
Other Foreign Countries	781,600	$8\frac{3}{4}d.$	28,331	1·1	3·9	7·6
Total from Foreign Countries	6,093,280	Average $8\frac{1}{4}d$	204,850	41·5	56·6	59·1
New Zealand	2,808,000	$7\frac{1}{2}d.$	86,218	43 5	30·4	27·2
British India	692,100	$7d.$	20,186	12·2	9 6	6·7
Australia	273,300	$8\frac{1}{4}d.$	9,833	2·8	3·4	2·6
Other British Possessions	456,800	$8\frac{3}{4}d$	13,082	...	...	4 4
Total from British Possessions ...	4,230,200	Average $7\frac{1}{2}d.$	129,319	58·5	43·4	40·9
TOTAL ...	10,320,000	Average $7\frac{3}{4}d.$	334,169	100	100	100

The imports increased from 8,000,000 lbs. in 1921 to 10,300,000 lbs. in 1923. Their value in the last-named year amounted to over £334,000. In the United States the imports for the same period have risen from 9,717,000 lbs. to 26,489,000, while the home production has grown from 9,720,000 to 21,368,000 lbs., making a total consumption for 1923 of 47,860,000 lbs.

The principal exporting countries are France, Argentine and the British Dominions. As would be expected the exports from

these countries have greatly increased. New Zealand in 1921 exported 3,550,000 lbs., which increased to 5,216,000 in 1923. Australia during the same period increased its exports from 680,000 lbs. to 2,196,000 lbs. The Argentine, which is one of the largest exporting countries, shows an advance from 5,050,000 lbs. in 1914 to 22,034,000 lbs. in 1923. Canada exported 1,234,000 lbs. in 1921 and 380,000 lbs. in 1923. Little information is available regarding the position in European countries, but the figures quoted are sufficient to show the existence of a rapidly growing demand for casein.

In 1920 over 4,360,000 lbs. of casein were exported from Great Britain and Ireland and 837,000 lbs. in 1923; notwithstanding the fact that over 10,000,000 lbs. were imported in the last-named year. The decrease in the exports was no doubt due to an increased home demand. The present production is estimated at from 560,000 to 1,120,000 lbs. There appear to be four factories in the British Isles producing commercial casein, and two producing a much purer article used in the preparation of proprietary foods and medicines, and the total production amounts to about one-tenth of that imported.

Before contemplating the manufacture of casein one of the first essentials is to ascertain the quality, quantity and regularity of the supply of separated milk. It is not considered advisable to set up a casein factory unless 100 tons of casein can be obtained for the season. Its preparation requires skilled technical control if a product of good quality is to be ascertained. The necessary machinery includes centrifugal evaporators, filter presses, wooden vats and the usual accessories for power machines. The capital outlay is not large. Information respecting costs of production is available.

The by-products, namely, milk, sugar and albumen, contained in the whey are important considerations. From 100 lbs. of milk in the process of manufacture of casein the following products are obtained:—

Butter	4 lbs.
Buttermilk	10 „
Separated milk	87·5 „
Casein	3·5 „
Milk sugar	2·5 „

including also albumen and molasses.

Closely linked with the industries of butter and casein making is the raising of pigs. In fact the piggery has become the adjunct of the casein factory, just as the latter is the adjunct of the butter factory.

The following summary of its more important uses enables an opinion to be formed of the almost unlimited application of casein in the arts and industries. It is used in the paper industry for (*a*) waterproofing paper and cardboard; (*b*) sizing and enamelling; (*c*) strengthening and rendering paper impervious to water, oils, etc.; it is largely used in the manufacture of glues, adhesives and cements.

Hardened casein is sold under various trade names—galalith,

ingalite, lactoform, cornalith, lactite, aladdinite, silicite, erinoid, &c., and used as a substitute for horn, celluloid, bone, ivory, ebony, amber, chinese jade, coral, tortoise shell; it is used in making electric fittings, combs, buttons, beads, brooches, buckles, draughts, paper knives, knife and umbrella handles, door knobs, cigarette holders, ash trays, organ stops, piano keys, etc.; in cold water paints, distempers and varnishes, casein acts as an emulsoid and as a covering; in the textile and leather industries it acts as mordant in calico printing for finishing, etc.; it improves the hardening and lathering power and retention of perfume of soap; it acts as a binder and increases the strength, water and fireproof properties of asbestos; it is an emulsoid for oils, fats, wood, tar, &c.; it improves the emulsifying, spreading and adherent properties of sprays; in photography it is a medium for photographic films and for the preparation of sensitized paper, etc.; it is used in the manufacture of oilcloth and in the tanning industry; it is found in many proprietary foods such as sanatogen, nutrium, sanose, nutrose, eucasein, synthetic milk, etc. consumed by infants, dyspeptics, diebetics, etc.; in medical preparations it is used as an ointment, as a vehicle for administering mercury and other substances, and as an emulsifier in cod liver oil preparations, etc.; and it is also used for clarifying fruit juices and wines, as imitation mother of pearl, for picture mouldings, and in the manufacture of all kinds of pomades and paste from face massage creams to boot polishes.

The foregoing summary is proof of the possibilities which the arts and industries offer for the future expansion of the casein industry. Since the demand for casein is likely to increase it seems worth while enquiring into the chances for its manufacture upon an economic basis in this country. Since it is a milk product the growth of a successful casein industry would be certain to react favourably upon the milk trade

These few notes, admittedly somewhat disconnected, are made solely for the purpose of creating enquiry and interest in a section of the dairy industry which up to the present has received but little attention in this country.

FARM PESTS—BIRDS.[1]

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DAMAGE TO GREEN CROPS AND ROOTS.

IT is customary to group birds, according to their feeding habits, as "insectivorous" or "vegetarian." Although this rough grouping may indicate the predominant habits of the birds, it must be regarded as no more than an indication, for few of the "insectivores"

[1] Articles in this series, dealing with Mammal Pests, commenced in the JOURNAL in July 1912. The first article on Bird Pests appeared in January 1924.

but turn occasionally to plant food, and none of the "vegetarians" but snatch the handy insect. Of the plant food devoured by birds, green crops and roots make up a relatively small proportion from the economic standpoint, when compared with the amount or value of the destruction wrought upon grain crops. Yet examination of their food content shows that there are few birds in whose dietary does not appear the "miscellaneous vegetable matter" which represents fragments of leaves, buds and the like. The frequency of its occurrence, though it be in small quantity, suggests that birds may find in green food, as mammals do, some necessary element of a healthful diet.

Like grain crops, green crops are specially liable to attack at two stages of growth—in the tender stage of development when the fresh leaves of the seedling plant appear, and when, as a rule, there is a scarcity of food for many birds, and in the mature stage, when seeds offer an inducement to a limited few.

Grass and Clover.—In a preceding section it has been shown that sprouting grain suffers particularly from the unwelcome attention of skylarks, woodpigeons and starlings, and since there is little to choose in the matter of edibility between the tender succulent leaves of early corn and of early grass, the latter suffers from the same group of birds. Of these the starling is the least harmful, and the damage to grass caused by skylarks and woodpigeons depends upon the autumn immigration of large numbers of these birds, and the shortage of food brought about by hard weather. In the case of the skylark, as has been indicated in discussing the relation between immigration and harmfulness (p 42), the damage is confined to the more southern countries of England, but as regards neither species can it be said that the grass crop is often seriously injured.

Clover undoubtedly suffers more damage from larks and woodpigeons, but the latter are much the worse offenders. Before the harvest is cut and after the stubbles have been cleared, the woodpigeon turns to green food, and amongst other things devours the leaves of red clover, frequently destroying the plants over considerable areas. Of 388 woodpigeons examined by him, Dr. Collinge[1] found clover leaves in 67 individuals, a total only exceeded by the number found guilty of taking barley grains; and the late Sir John Gilmour, who recorded the examination of 265 birds, was so convinced of their destructiveness that he remarks, "the clovers accuse him most strongly . . . though grain be left entirely out of count, the pigeon stands utterly condemned by the heavy black score still standing against him for root-crop and clover-leaf destruction."[2] The monthly records upon which this conclusion was based show that while the woodpigeon apparently finds more desirable fare in October and November, in all the other months it is liable to take clover leaves.

Leguminous Crops.—The legumes, such as peas, beans and tares or vetches, though they are not subjected to any general attack by birds suffer in some areas from the different species of

1 "The Food of some British Wild Birds," p 67.

2 *Trans Highland and Agr. Soc. Scotland*, 5th Series, vol. viii, 1896, p 28.

pigeons. Of these the woodpigeon, because of its greater numbers, is the most destructive. Parties of woodpigeons have been known, during the hard weather of winter and spring, to visit repeatedly stackyards where peas and beans were stored, and their voracious appetites made short work of the young shoots of peas, beans, tares or vetches when these first appear. Many a crop of legumes has been eaten to the ground and ruined by these pests. The mature crop also suffers to a certain extent, Gilmour's statistics showing that a small proportion of the birds shot in October, November and December contained the seeds of peas, beans and tares. Damage of the same nature is done by stock-doves when they are numerous, and even by turtle-doves, but the relative rarity of these two species makes their depredations of much less account.

Rooks also take beans and peas. The country view is crystallised in the old rhyme:—

> "Sow four beans as you make your row ;
> One to rot and one to grow,
> One for the pigeon and one for the crow"

But the traditional view must be taken with a grain of salt, for the analyses which have been made of the food of the rook suggest that they seldom have recourse to such a diet, though it is sparingly made use of in each month from November to April.[1]

Cabbage, Rape and Mustard.—The cruciferous crops of the farm suffer as do the legumes, in their early stages of growth. At this period woodpigeons and skylarks are again responsible for most of the damage, but this is more noticeable in the southern counties of England. In Britain as a rule sowings of these crucifers take place later than sowings of the legumes, with the result that when they are postponed till April, the majority of the immigrant woodpigeons and skylarks, which do so much harm during the winter months, have left Britain for their continental breeding areas.

The severity of the winter and consequent scarcity of bird food is, in the case of crucifers, as in the case of most green crops, an important factor in determining whether or not a crop may escape injury. "It is in hard weather," says Mr. F. V. Theobald,[2] "that larks become a serious nuisance, for they will then strip whole fields and gardens of winter greens", and Mr. Arthur Amos, M.A., Director of the University Farm, Cambridge, cites a case in point in a letter written to me on 23rd January 1926. "Last Friday, Saturday and Sunday, January 15th, 16th and 17th, skylarks were doing very serious damage to four acres of spring cabbage planted on the University Farm, the leaves of which were just projecting through the snow and formed the only green stuff available to the larks. The only form of scaring that had avail at all was shooting, and even then the survivors flew only from one part of the field to another. During Saturday we killed 50 and on Sunday nearly as many. After that the snow melted and our troubles ceased. Exactly the same experience happened to my father on his cabbage plants at Wye in Kent during the same three days."

[1] See the statistics collected by Theobald and M'Gowan in *Supplement to the Journ. of the Board of Agriculture*, May 1916, p. 10 *et seq.*

[2] *Science Progress*, 1907, p. 275.

Cruciferous crops are also liable to suffer in their ripening stages where they are grown for seed. This is particularly true of mustard, both the white and black varieties of which are extensively sown in the eastern counties of England for the sake of the seed, to be ground into table mustard. At the time of ripening, towards the end of August, linnets and greenfinches prove most destructive. How serious may be the harm done is indicated by evidence given before the Departmental Committee on the Protection of Wild Birds,[1] to the effect that bird-catchers travel even from London to Lincolnshire in order to catch linnets which are damaging the farmers' mustard seed. The bird-catchers are hired by the farmers, but so great are the numbers of linnets caught that the wages often consist merely of the captured birds, although payment is generally made for the catching of sparrows, starlings and greenfinches. The linnets are mainly British-bred birds which have congregated and are moving southwards preparatory to emigating to the Continent for the winter

Turnips.—At each stage of development turnips and swedes are appreciated by one or other of our native birds. Early turnips may make their appearance before the hordes of continental skylarks which winter in England have departed, and the seedlings as soon as they show above ground suffer in consequence. Chaffinches and woodpigeons also attack the tender first shoots, but the latter, less particular than the others, do not confine themselves to these, and under press of necessity make substantial meals off the green tops of mature turnips and swedes. In the investigations made by both Gilmour and Collinge, the leaves of these roots take third place in order of frequency, the number of individuals in which they were found being exceeded only by the records of barley grain and clover leaves.

That the damage done at both stages may be considerable is shown by the figures recorded by Gilmour in the paper already referred to. Interest is added to the statistics from the fact that they relate to birds killed in a well-cultivated arable district in Fifeshire. The destruction of mature leaves, according to these figures, is confined to the five months from December to April, but it is during January, February and March that it is at its height. In these months in 1895, when the investigation was in progress, the leaves of turnips and swedes formed the staple food of the woodpigeons. In January, 21 birds were killed and examined, and of these 18 contained turnip leaves, not in driblets but in mass, "packed" the investigator says of six individuals, that is with both crop and gizzard full, and eight others are recorded as "full." So in February, of 18 woodpigeons which contained food, four were "packed" with turnip leaves, six were "full." In March the record was scarcely so heavy, but it was more damaging, since seedlings now enter the lists, and crops packed full of the tender second leaves must represent a considerable deficit in the possibilities of the ultimate crop, although allowance must be made for the fact that in the case of this crop drastic (but regulated) thinning enters into the normal scheme of cultivation.

[1] Report of the Departmental Committee on the Protection of Wild Birds, 1919, p. 36.

Turnip roots suffer from a greater variety of plunderers than any other crop in the present category. The woodpigeon takes its share here also, holing the turnips, and so admitting frost and rain to their final destruction, but the share is not of much importance, and would appear to be confined to the severest weather, when other food is unobtainable. So it is also with the rook. A surprising fastidiousness of taste is revealed by the few records of mangold and turnip fragments[1] found, generally in February and March, in a bird which shows so great a liking for potatoes.

If, however, the regular root thieves fight shy of turnips, their abstinence is compensated by the attentions of outsiders. In hard weather the immigrant flocks of grey-leg geese sometimes attack turnips in fields near the estuaries where they have settled for the winter, and gulls, particularly the common and the black-headed gull, are developing a tendency more and more to have recourse to roots when necessity spurs them In some areas the tendency threatens to become a habit; in North Ronaldshay, in the Orkney Islands, turnips have formed a staple part of the autumn food of gulls for close on forty years, and during the last fifteen years the turnip-eating habit has become common in parts of Aberdeenshire.

In the last stage of all, when the reserved patch of turnips or swedes is ripening its seed for a future sowing, greenfinches and, less persistently, chaffinches may descend upon the clump in flocks. In some districts the destruction of the seeds is so great that the crop cannot safely be allowed to ripen and, gathered before its time, must be dried under cover.

The attractiveness of turnip seeds even induces these finches to seek them in the seed-bed, and flocks of greenfinches have been known to clean out newly sown areas of considerable extent.

Potatoes.—Unlike turnips, potatoes offer but one source of food to birds. There is no trace of damage to shaws even in their most tender stage of growth, the tubers are the only attraction. During the months of December, January and February, Gilmour found that, in his district in Fifeshire, potatoes along with turnip-tops formed the main food supply of woodpigeons, but there was evidence in at least one case that the tubers, small or diseased, were refuse gathered from the fields after the crop had been lifted.

The inland gulls, "common" and "black-headed," occasionally devour potatoes, and though the practice, confined to hard weather in autumn, is far from common, it seems to be one to which, as the number of gulls increases, more individuals become addicted.

Of the potato-destroyers, however, the rook is the most persistent. In spring it may dig up and devour newly planted "sets," and in the autumn it returns to the fields for the waste left after the crop has been lifted, a negligible if not even useful activity, which is unfortunately also associated with attacks upon the good potatoes in the pit.

Gilmour's statistics, though they refer to a very limited area and to only one round of the seasons, probably give a very fair picture of the general relations between rooks and potatoes. He

[1] Theobald, M'Gowan and Leigh in *Supplement to Journ Board of Agriculture*, 1916, pp. 13, 15 and 53.

found potatoes amongst the rook's food in six months of the year —January, March, May, June, August and December—but the quantitative distribution of this crop in the birds showed that the damage was centred about the two periods above mentioned. Thus the main attacks were in May, when out of 33 rooks containing food, 11 had potatoes in various amounts, and in December, when of 21 rooks, ten contained potatoes. The spring attack, which continued into June, lasted about five weeks, from the second week in May till the 18th of June; and the winter attack lasted from early December till late January.

Although Gilmour found that 36 out of the 336 rooks examined, or rather under 11 per cent., contained potato, a scrutiny of his detailed statistics shows first, that only in four cases was potato consumed to the exclusion of other kinds of food, and secondly, that during no period could potato be regarded as a prime or staple food stuff

The Rook—For and Against

Thus far we have traced step by step the attitude of the rook to the crops of the farm. Now it becomes desirable to define the attitude of the farmer to the rook. And since a reasonable attitude cannot be assumed on a one-sided statement of the case, the following paragraphs summarise the arguments for and against the bird, and suggest a judgment in keeping with the evidence.

The Case against the Rook—We have seen that rooks do serious damage to corn crops, in the seed-bed, in the ear and in the harvest field (*see* this JOURNAL, 1925, p. 173) that they occasionally take peas and beans, that on rare occasions they peck holes in turnips in winter, and that more often they dig up and eat potatoes from the spring "settings" and from the mature crop. We shall see, in a subsequent paragraph, that in fruit growing regions, such as the Blairgowrie district of Perthshire, they may damage raspberries and other fruit. And, finally, though the fact may be of less interest to the farmer than to the sportsman, they take the eggs of pheasants and other game birds It is a grievous tale of ill deeds that has been emphasised in these pages, but fortunately it is not the whole story

The Case for the Rook—Rooks destroy a certain amount of weed seeds. Seeds of charlock, goosegrass, knotgrass, dock, buttercup and bindweed have been found amongst their food, but such diet is not common, nor is it taken in any quantity. Moreover, any benefit derived from the destruction of some weed seeds is to a certain extent counteracted by the dispersal of other undigested seeds in fresh areas

There can be no hesitation, however, in crediting rooks with the destruction of vast numbers of harmful insects Where statistics have been collected throughout the year it has been shown that in every month insects have formed a share of the diet, though, naturally enough, in the winter months, when the only insects available lie hidden and often inaccessible because of the frozen ground, the numbers fall markedly away.

The insects devoured are of great variety, and some of those most

harmful to farmers' crops are amongst the commonest items in the rook's dietary. Thus, of the beetles, the destructive wireworm, grub of the click-beetle, takes first place in frequency, though other harmful forms, such as chafer larvæ and weevils, also make up a fair proportion. On the other hand occasional specimens of useful forms, such as the carnivorous ground-beetles, are also taken. Equal in importance to the destruction of wireworms is that of leather-jackets or "grub," the larvæ of the "daddy-long-legs," but other two-winged flies (*Diptera*) are almost unrepresented in the food, or it may be have gone unidentified.

Moths and butterflies appear in the rook's food in their larval stages, none of which can be regarded as other than harmful. These include, among a wide variety, numerous examples of the destructive "surface larvæ" of the turnip dart moth and its relatives. Of other insects, sometimes a few plant lice or aphids and a few bees and wasps are found, but their scanty numbers are of no account

As for the rest of the animal world, the rook makes desultory warfare upon a wide range of creatures. Millipedes occur not infrequently, though the rook makes little distinction between the vegetarian, and therefore harmful, millipede and the carnivorous and useful centipede Fairly often earthworms occur, now and again land-snails, the eggs of birds, even small birds themselves, and sometimes field-mice

The quantity of insect food taken, as well as its nature, bears upon the problem of the rook's usefulness In this respect the statistics collected from stomach contents afford ill guidance, for insects and especially insect larvæ are frequently soft-bodied, easily digested organisms, the remains of which are in a relatively short time reduced to an unrecognisable pulp in the bird's food-canal. It is not surprising therefore that, while stomachs "packed full" of grain frequently find a place upon the lists, records of stomachs "packed full" of insects are noticeably absent. Yet in spite of this, the fact that rooks may feed to repletion on insects harmful to the farmer has been shown by food-content examination of birds casually collected. Thus Mr Leigh records in the paper already referred to (p 52) that in a single gizzard from Cumberland he found 95 whole Tipulid larvæ, "leather-jackets," and that as many as 103 Elater larvæ, "wire-worms," were present in another.

Statistics and stomach contents apart, there are many instances where the influence of rooks upon insect pests has been forced upon the notice of observers. Several of these are quoted by O. V. Aplin,[1] who describes actual cases of swede crops saved from "grub," pastures on Skiddaw from caterpillars, grass fields from chafer larvæ, all by the voracious agency of rooks. He repeats Jesse's story of the rookery he knew, which, at the request of the neighbouring farmers, was destroyed, but which in two years they were anxious again to reinstate because of the increase of destructive ground insects during that short lapse of time. Such spectacular examples of the rook's beneficence can scarcely all be regarded as coincidences, nor can the fact that they refer to

[1] See his article on the Rook in John Watson's "Ornithology in relation to Agriculture and Horticulture," 1893.

unusual plagues deprive us of the argument that in ordinary circumstances rooks do similar good though on a lesser scale

It is a matter of common observation, also, that where turnips or other crucifers are looking limp or "dwining" under the attentions of the grub or other ground larvæ, rooks pluck up the limp plants for the evil gnawing at their roots. This habit has an unfortunate sequel, for Mr. R. Hobbs of Kelmscott and other farmers have told me that the limp appearance of newly singled turnips seems on occasion to mislead the rooks, which search the drills, pulling up and examining the plants for the supposedly hidden insect

The Balance of the Argument.—The case for and against the rook having been thus summarily stated, it remains but to balance the one side against the other in the hope of gaining a clearer notion as to the general standing of the bird towards agriculture. This obviously is a matter of statistics.

While many capable workers have made examinations of the contents of rooks' stomachs, four British investigations stand out by reason of the number of birds examined. Dr. W. E. Collinge examined 631 rooks [1], the late Sir John Gilmour, 355 [2], Messrs. F V. Theobald and W. M'Gowan, 277 [3], and Mr. H S. Leigh, 209 [4] To the sets of figures laboriously collected by these investigators I shall endeavour to apply a reasonable interpretation, since their own conclusions are sometimes at variance.

It must be premised that to gain a fair view of the rook's activities, individuals must be collected in every month throughout the year, and that the monthly total results must be reduced arithmetically to comparative levels, or better still to numbers which represent month by month the relative fluctuation of the rook population, which as we have seen is affected by autumn immigration and spring emigration In none of the investigations mentioned has this simple method of eliminating the effect of the unequal monthly collecting of birds been adopted, but Gilmour's figures, representing a fairly large number for each month, the maximum being 65 in May and the minimum 29 in November, afford the best basis for monthly comparison Neither Collinge nor Leigh, whose account is a preliminary one, give the monthly totals of the birds examined.

The relation of insect consumption to grain and root consumption, that is agricultural benefits ranged against agricultural damage, shows a distinct swing throughout the year according to Gilmour's tables Insect consumption is at its highest during May, June, July and August, in each of which the numbers of birds containing insect food almost balance the number containing grain, and in June and July markedly exceed them. Collinge's diagram of monthly consumpt (p. 57) shows that in his examination, also,

[1] Collinge's "Food of Some British Wild Birds," p. 56 Collinge gives percentages for 830 birds examined by himself and Mr. D. T. Thring, but the results stated have been obtained by adding the *percentages* of three investigations and dividing by three, a fallacious statistical method, since it accords to percentages obtained from 58 birds equal weight with percentages obtained from 631. Attention is therefore confined to his major examination

[2] *Trans. Highland and Agr Soc. Scotland*, Ser. 5, vol viii, 1896, p 60.

[3] *Supp Jour. Board of Agr*, May 1916, p. 9.

[4] *Ibid*, p 51.

the same months stand out on account of the animal matter eaten, his maximum taking place in July, as Gilmour's does when his figures for June and July are reduced to the same standard.

In the light of this result turn to the figures collected by Theobald and M'Gowan. In 1912, of a total of 146 rooks, they examined only 18 in these critical four months, May to August,—August being entirely unrepresented; in 1913 of 92 birds for the year, 17 were in May, 0 in June, 3 in July and 0 in August. In 1914 the collections ended in May when 7 birds were examined. That is to say, of the 277 rooks upon which their report is based, 45 only were obtained in that third of the year when, according to more complete statistics, insect food is at its maximum; and of these but 13 represented the two months, June and July, when in Gilmour's area more birds took insects than took grain. Clearly the results of this investigation, when totalled without adjustment to meet the varying monthly numbers of birds, are heavily biased against the rook, and it is not surprising to find the authors close their enquiry with these words, "it may be concluded from this particular survey that the rook is a harmful bird, and that the opinion of the part it has been supposed to play as a destroyer of such insect pests as leather jackets, wireworms and chafer-grubs is not endorsed."

But the conclusion, as a general survey of the rook's food *throughout the year*, is not valid; the poor birds were not permitted to show their paces in the months most favourable to them, they were deprived of full opportunity of leading evidence in their own defence.

A comparison of the numerical results of the remaining investigations may be made in tabular form, the numbers of rooks taking the main types of food being shown on a percentage basis.

TABLE showing the relative frequencies with which the main sources of food are taken by rooks, expressed in percentages.

Investigator.	Number of Rooks examined.	Grain.	Roots, &c.	Insects.
Collinge	631	70	15	9
Gilmour	355	58	7	23
Leigh[1]	209	56·5	15·5	28

In each of these investigations the number of times that grain and roots were taken (harmful activities) far exceeds the numbers of times of insect capture (generally beneficial activities). Founding upon his own investigation, Gilmour reaches the following conclusion:—"Taken altogether, *the rook has almost no claim to agricultural regard;*[2] his thieveries and rogueries look very black, for do we not catch him 19 times at artificial foods and 9 times

[1] The figures given by Leigh (p. 52), which represent the numbers of times particular foods were found in 100 rooks, have been reduced to a true percentage basis, for comparison with the other results.

[2] My italics.

more at cakes and such-like, let alone his destruction of our crops when using them for food or when hunting in them for his favourite insects? There is, indeed, not much to choose between the thieving rook and the gentle dove."

Collinge reaches a somewhat similar conclusion:—"There is ample evidence to show that with the present large number of rooks a grain diet is preferred. So far as the evidence of this enquiry shows, the rook is not a particularly beneficial bird to the agriculturist, although its usefulness might be considerably increased were it less numerous."

Leigh, whose percentages very closely resemble Gilmour's results, comes to a somewhat different conclusion, for he is inclined to stress the amount of insect destruction:—"The rook appears to feed largely upon insects in all stages during certain periods of the year, but it is not very particular as to its diet, and if the supply of insects falls short (as it does during the winter months), a good deal of grain and other food is taken."

Where does the truth lie amidst the conflicting opinions? On the whole, Leigh tends to underestimate the part played by grain in the rook's diet, for Gilmour shows that not only in winter but in every month of the year grain is found in the food, to such an extent, indeed, that he goes so far as to say—"Is not the broad fact clear that grain is the staple of staple foods for rooks?"

In interpreting the statistics two considerations must be allowed due weight. In the first place, since animal food is more easily digested, it disappears more rapidly from the stomach than corn grains. It may, therefore, be assumed that the total of insect food shown in stomach counts falls short of the total taken by the birds, when considered relatively to vegetable food.

In the second place the fact that grain appears abundantly in almost every month ought to have raised suspicions as to its source. It has created some comment. Theobald and M'Gowan say—"How rooks obtained wheat, &c in some of the summer months was not found out." Gilmour, while admitting that some of the grain was obtained from dung, adds, "but the how much from dung question is, after all, not of great practical import, for is not the broad fact clear that grain is the staple of staple foods for rooks?" Yet surely the source of the grain devoured is of the greatest practical import. The farmer can have no interest in the spent grain gathered from road-droppings, in the spent grain in farmyard manure, in the waste grain of the stubble, the grain spilt at railway sidings and so on. But the investigators total it carefully up against the rook without eliminating a single grain—a glaring case of hanging on a not-proven indictment.

Admitted that the rook takes grain at spring and autumn sowings and from the ripened crop, standing or cut, there remain many months outwith these stages of the farming year. Where did the rooks get their considerable quantities of grain in December, January and February, in May, June and July, even in late September and early October? Certainly not much from the useful grain of the year's crop. An impartial judge would decree that during six or seven months of the year the grain counted against the rook should be ruthlessly eliminated, or relegated to

the list of its neutral activities, unless it has been proved to have been taken to the farmer's detriment.

This alters vitally the aspect of the statistics. Grain and insects now approach a closer relativity in the rook's dietary, and we are left with only one more problem to face, the balancing of two incompatibles, vegetable matter and animal matter.

Obviously this balancing is not the simple matter of calling "all equal" at a 50-50 percentage of units or of volume. A corn grain from the sowing is of more value than a grain from the ripened crop, for in it lies the potentiality of a season's increase. And an insect grub, in which lies the potentiality of the destruction of many heads of corn, must be reckoned as the equivalent of many grains; so that a relatively low percentage of harmful insects destroyed may well mean the saving to the farmer of a relatively high percentage of corn grains

The conclusion regarding the Rook.—Allowing for all these niceties but necessities of interpretation, I have come to the conclusion that the statistics available show over all a balance in favour of the rook—that it does more good to the farmer than harm. To those, and they will be many, who object to this conclusion, I can only say that while the damage done by rooks is obvious, the good they do is seldom seen and less seldom realised—"the evil that men do lives after them, the good is oft interred with their bones"

But some of the objectors, founding on their own experience, may be right, and for them there is a word of cheer. All the investigators I have referred to, with the exception of Sir John Gilmour, have made the mistake of trying to account for the *average* rook on *average* agricultural land. Gilmour wisely kept his rook collecting within the bounds of an area of definite agricultural character, so that for that type of area his results, properly interpreted, are valid. While, over all, the average rook on average agricultural land is, according to my reading, beneficial to the farmer, that is not to say that in some areas it may not do more harm than good. The only reasonable way of estimating with any accuracy the rook's place in agriculture is to consider its activities in relation to the predominant type of farming. In the following short paragraphs I shall endeavour to carry out this kind of estimate, but in the absence of statistics collected with a view of elucidating this aspect of the rook problem, the comments must be regarded rather as a matter of personal judgment than of scientific infallibility.

Hill pasture—Here the activities of rooks are confined to the destruction of insects and insect larvæ, and the birds are wholly beneficial.

Mixed hill pasture and a little arable—In such a case the addition of a small amount of arable land very considerably alters the rook's standing where the arable land is largely given over to corn crops. While the birds still benefit the pasture, if they are plentiful they do a great amount of damage to the limited crop in spring and autumn. Mr. Walter Stewart records an excellent illustration of this in the south-eastern area of Lanarkshire.[1] In

[1] *Scottish Naturalist*, 1923, p. 144.

this area not more than 10 per cent. of the county's arable land is to be found, but in the narrow valleys rooks fall upon the corn, and "the ground underneath the nests soon becomes absolutely littered with grain husks in the spring and autumn." "Bitter complaints are made against 90 per cent. of the rookeries in this area." In such areas a limit must be put to the increase of rookeries, though even here the total destruction of the rooks would probably be fatal to the pasture.

Arable with predominant pasture.—In such areas, which may be taken as typical of the dairying type of farming, rooks do much more good than harm. Such an area is the north-west section of Lanarkshire, about which Mr. Stewart writes, "while the north-west area contains fully 80 per cent. of the rookeries, the breeding stock only amounts to 44 per cent.; and we must take into consideration that this area includes at least 90 per cent. of the whole arable land of the county. A large part of this is given up to the growing of hay, and yet another very large part consists of fine old pasture. Land of this nature is admirably suited to carry a moderate stock of rooks, and to derive no little benefit therefrom."

General mixed arable.—Sir John Gilmour's investigation concerned such an area in Fifeshire, and, as I have indicated, it seems to me to show that on the whole the balance to the good lay with rooks, in the numbers in which they then were present. In any case his wholesale condemnation is scarcely justified by a reasonable reading of his statistics. Probably the balance in such an area is very near to equilibrium, and slight alterations in local conditions may cause it to tilt to this side or that.

High cultivation.—In the areas, of limited extent and distribution in Scotland, where grass land is at its lowest and its place is taken by intensive cultivation of grain and roots, rooks are likely to be seen at their worst. I have little doubt that here restrictive measures against the rook population must be carried out regularly and systematically.

FARM IMPLEMENTS IN SCOTLAND.

HISTORICAL NOTES.

Professor J. A. SCOTT WATSON, M.C., B.Sc., Oxford University.

III.—1800–1850.

The Reaper.—Before the end of the eighteenth century several agricultural writers had speculated on the possibility of mechanical reaping, but none held out much hope of a solution of the problem. Even as late as 1813, after one or two models had been built and patented, a "most respectable correspondent" of Sir John Sinclair wrote[1] that "Of all the improvements hitherto attempted that of the reaping machine seems the most hopeless. The varieties of soil, surface and situation of the crops it has to contend with appear almost insurmountable bars to any machine of the kind

[1] "Account of the Systems of Husbandry, &c. of Scotland," 2nd edn., Appendix XV.

ever proving useful. It is well known to every agriculturist that the difficulties attending the reaping of laid and twisted crops requires not only eyes, hands, fingers and feet, but also a moderate share of judgment. Now, even suppose a machine to possess all these qualifications and shut its eyes, what could it do?"

At the time in question, and for many years afterwards, the normal practice was to reap corn crops with the hook, although in certain districts the scythe, with a cradle or hake attachment, was used for barley and oats. The slowness of the operation and the enormous numbers of casual labourers that had to be employed to get harvesting timeously done are well remembered by people still alive.

The first hint that mechanical reaping was being considered as within the bounds of possibility appears to have been an offer, made by the London Society of Arts in 1780, of a gold medal as a premium for a reaping machine The only result of this was a suggestion, published in Arthur Young's *Annals of Agriculture* for 1785, that a machine such as those described by Pliny (A.D. 23) and Palladius (A.D. 391) might be reconstructed; it is quite clear, however, that the machines in question, like that mentioned by Googe in the sixteenth century, were not reapers, but merely headers or strippers, which removed the ears by means of a sort of comb, and left the straw upon the ground.

The first patent for a reaper was taken out by Boyce in 1799. In this the cutting mechanism consisted of a wheel, armed with a series of short scythes, which was made to revolve by means of gearing from the axle. "It was destitute, however, of any mechanism for gathering and depositing the corn after being cut, and hence it never reached any degree of success."

In 1803 the Highland Society offered "To the person who shall invent the best and most approved machine for reaping, which upon trial shall be found, to the satisfaction of the Society, useful in saving labour and expense—simplicity of construction being deemed an essential part of its merits—a gold medal, or a piece of plate of the value of ten guineas, or that sum of money." Two years later the said premium was awarded to a millwright from Castle Douglas, named Gladstones, for a machine which is fully described and figured in the *Farmers' Magazine* for 1806. Gladstones' machine had for cutter a revolving wheel mounted with a continuous smooth-edged circular knife; projecting over this was a series of fixed, pointed fingers, which held the corn up to the knife. An upper wheel, also revolving horizontally, carried a pair of three-pronged forks which gathered the cut corn in handfuls and carried it to the side, where it was delivered under the shafts. A rather ingenious tripping mechanism caused the forks to tilt backwards when they reached this point, and so prevented the corn from being carried round the circle. It is said that the cutter worked tolerably well on level ground, but that the gathering apparatus was a failure. It is interesting to note that Gladstones' machine was *pulled* (and not pushed) by the horse, which walked alongside the standing corn in a pair of long shafts.

Smith of Deanston, near Doune, in Perthshire, who is remembered chiefly for his work on drainage, brought out his

original reaper in 1812; the next year, after certain improvements had been introduced, the machine was examined and tested by committees of the Dalkeith Farming Society and of the Highland Society, each of which gave rather a favourable report and awarded a premium of fifty guineas. This machine was pushed by a pole which projected behind the frame, and to which a pair of horses was yoked. The cutter, like Gladstones', was on the rotary principle, and circular, but the knife consisted of a number of separate segments, so that damage might be more easily repaired. Above the cutter wheel, and spinning on the same axle and at the same speed, was a drum, which gathered, or rather threw, the corn to one side, where it fell in a fairly regular swath. The cutter and drum could be made to revolve in either direction, the corn being delivered either to the right or left as desired.

Between 1820 and 1832 Joseph Mann of Raby in Cumberland applied himself to the problem and his efforts culminated in a machine—interesting in principle but very crude in workmanship—which was exhibited and tried at the Highland Show at Kelso in the latter year. Mann's reaper[1] again had a rotary cutter, which, however, was polygonal instead of round; it differed further from Smith's inasmuch as it was drawn by the horses in the same way as modern types; and lastly, it had an improved gatherer, a drum which carried a set of 25 rakes and which revolved at only one seventh of the speed of the cutter wheel—25 revolutions per minute as against 175. Attached to the near side of the frame was a fixed rake or comb, whose teeth passed between those of the revolving rakes and removed the corn from them, allowing it to drop to the ground. At the trial the machine performed with some credit, but the judges were unable to recommend an award. The gravest fault with this, as with all machines embodying a rotary cutter, was that in passing over ridges or across uneven ground the cutter edge was at times high above the ground level and at others scraping, or even cutting into, the earth.

In 1835, at the Highland Show at Ayr, Smith showed an improved reaper embodying the type of gatherer, with rakes, that Mann had invented. This was tried in a field of wheat and created something of a sensation. "Never perhaps did an experiment come off with better effect or greater success; the general impression was that the problem had at last been solved—that Smith's machine was complete."[2] The general impression, however, was wrong, for although Smith's machine was nearer to success than any of its predecessors, it never got beyond the experimental stage. It was cumbrous, especially in turning; it made no sort of shape over ridges, and it was too expensive to buy and to run.

It would be tedious to describe all the machines that were built and tried during the early part of the nineteenth century.[3]

[1] *Quarterly Journal of Agriculture*, vol. iv. (1834).

[2] "The Book of Farm Implements and Machines," by James Slight and R. Scott Burn, edited by Henry Stephens, 1858.

[3] For a complete list, see "Reaping Machines," by Jacob Wilson, *Transactions of the Highland Society*, Jan. 1864.

Up till 1818 the Highland Society had awarded a total sum of over £200 in premiums to inventors, but without much practical result. Rather curiously the one machine which can be said to have closely resembled a modern reaper attracted no particular notice, and was never officially tested. This was the invention of Brown and Ogle of Alnwick, in Northumberland, and was brought out about 1822. It was provided, like a modern reaper, with a fan or "flights", there was a cutter bar, armed with a set of projecting fingers or teeth, upon which rested the cutter, a straight-edged steel knife driven with a rapid reciprocating motion. The cut corn was thrown back by the fan upon a wooden platform and was cleared away, when enough had collected to form a sheaf, by a man with a rake. The machine was drawn by the horses. Hence, apart from the fact that the cutter was based on the principle of the knife instead of on that of the shears the whole construction bore a close similarity to that of the manual delivery reaper, which later became a standard type [1]

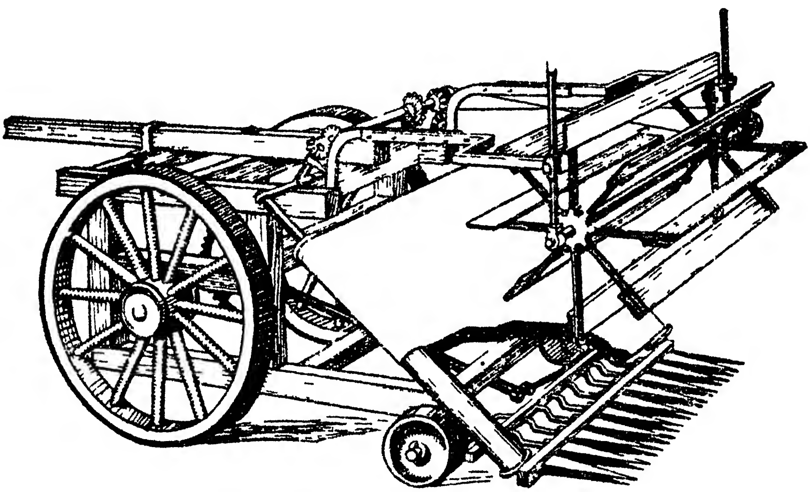

FIG 1 —Bell's Reaper

The application of the principle of the shears to the cutting mechanism, and indeed the invention of the first really effective reaper, was the work of Patrick Bell, who at the time (1826) was a student of divinity at St. Andrews University, and who later became parish minister of Carmyllie in Forfarshire. The main features of Bell's reaper can be seen in the illustration (fig 1). The fan, which was adjustable for varying lengths of straw, was driven by means of a belt The cutting mechanism consisted of a fixed cutter bar, carrying a set of 13 fixed blades, each 14 inches in length. Alternating with these were 12 other blades which were hinged or pivoted on the cutter bar. The moveable blades were extended backwards, and their tails were loosely attached to a cutter tail-bar which was given a rapid reciprocating motion when the machine was in gear, and so produced a

[1] *The Mechanics' Magazine*, 1826. Quoted by Slight and Scott Burn.

clipping movement of the blades. The cut corn fell backwards against a sloping endless web, like the cloth of a binder, and was by this means carried to the side and dropped in a continuous swath. Like Smith's machine, Bell's was pushed from behind by means of a pole, and like it, too, could deliver the corn to either side. In 1828 Bell showed his machine, and demonstrated its capabilities in the field, before a committee appointed by the Highland Society. The committee reported favourably and the Society awarded a premium of £50.

According to Bell's own account, it was possible, with eight women "lifting" and four men binding and stooking, to harvest 12 acres a day with his reaper. It is safe to say that the cost of the work was reduced to something less than half that of hand reaping, and of course there was the very important advantage of greater speed. This being so it is somewhat remarkable that the reaper was not widely and immediately adopted. It is true that a considerable number of machines were built during the 'thirties and 'forties, principally in Dundee, and that many of these "plodded their way from harvest to harvest" on Forfarshire farms for many years, moreover four machines were taken to the United States, where it seems likely they provided the basis on which M'Cormick, Hussey and others started, at all events all the American makers adopted a cutter which was similar in principle to Bell's, though simpler in form. But the fact remains that for 20 years after its invention Bell's machine made very slow progress; indeed it scarcely became known outside Forfarshire and Perthshire Even there, in many instances, its adoption had to await other agricultural improvements, such as the enlarging of fields, thorough drainage, and the necessarily gradual levelling down of the old narrow and steep ridges. The great Exhibition of 1851, where M'Cormick's and several other American machines were shown, gave a much needed advertisement to reapers generally. Thereafter Bell's model, as manufactured, with certain minor modifications, by Crosskill of Beverley in Yorkshire, came into fairly general use.

Unlike most great improvers, Bell was not left unhonoured by his own generation. He had a handsome presentation from the Highland Society, and was laureated by his University.

Improved Tillage—During the first half of the nineteenth century a great deal of attention was devoted to the improvement of tillage methods. In 1800 much of the land of Scotland was sour and wet, under which conditions little was to be gained by deep culture; but during the period of the Napoleonic wars a large proportion of the arable land was heavily dressed with lime; kilns were started up wherever limestone could be found, and where better material was not available lochs were dredged and mosses dug over for the shell marl that was often to be found in their bottoms. Later on an efficient system of under drainage was devised, and it soon became evident that such land as had been limed and laid dry was capable of repaying much more thorough cultivation than had previously been usual.

The man who, more than any other, deserves to be remembered in this connection was James Smith (1789-1850), the son of a

Glasgow merchant, who in 1823 came into possession of the farm of Deanston, then little better than a rush-grown marsh. He immediately began to experiment on drainage, and in the course of a few years worked out his system of parallel drains, 2½ feet deep and from 16 to 21 feet apart. The first foot of his trenches he filled with broken stones and the remainder with earth. The "rummle" drain was of course soon superseded, first by a channel of built stones, later by horse-shoe tiles, and finally by circular tiles, a really efficient machine for making the last having being patented in 1845. But Smith's system was essentially sound. Unfortunately when, a few years later, drainage came to be carried out on a large scale with the aid of Government loans, the rival system of Josiah Park was adopted in preference to Smith's. Park, basing his system on experience gained with moss land, insisted that drains should be 4 feet deep, and it is notorious that much of the money spent in laying such drains was entirely wasted.

It was an essential feature of Smith's system that drainage should be followed by deep tillage, and not the least of his services was the invention of a sub-soiler (fig. 2). By its means, and by the thorough drainage of every acre of the farm, Smith converted Dean-

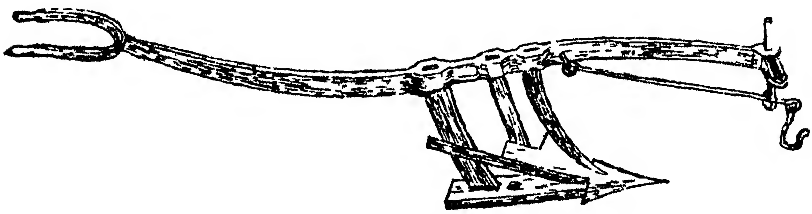

FIG. 2 —Smith's Subsoiler.

ston into a veritable garden. Among other of his inventions were a one-way plough and a chain harrow The latter, which appears to have been the first thing of its kind, was really more than an ordinary chain web, for it introduced the principle of the disc as well. It consisted of a large number of sharp-edged rings of cast iron, similar in size and shape to an ordinary playing quoit, which were connected by means of a web of quarter-inch wrought iron wire links. In 1831 Smith published his *Observations on Drainage and Deep Ploughing*, which created a great amount of interest.

Further work along essentially the same lines was carried on by the Marquess of Tweeddale at Yester in East Lothian during the 'thirties and 'forties. With a Mr. Ainslie he brought out one of the earlier tile-making machines, which was exhibited at the Highland Show in 1836. With Mr. Slight, a very capable engineer, he devised the Tweeddale plough, and a subsoiler of better construction than Smith's. By drainage, deep ploughing and subsoiling he effected a wonderful improvement on the poor Yester land, and provided a very valuable object lesson.[1]

Meanwhile a number of men were at work upon the grubber, which at the beginning of the century was rather a primitive and ineffective tool, having a wooden frame and perpendicular tines,

[1] See "Yester Deep Land-culture," by Henry Stephens, F.R.S.E. (1855).

with a pair of wheels in front. It was indeed little more than a heavy harrow, which could be in some degree controlled as to depth of work by means of the wheels.

The first notable improvements were made about 1820 by Finlayson, a farmer at Kaims in the parish of Muirkirk, Ayrshire,

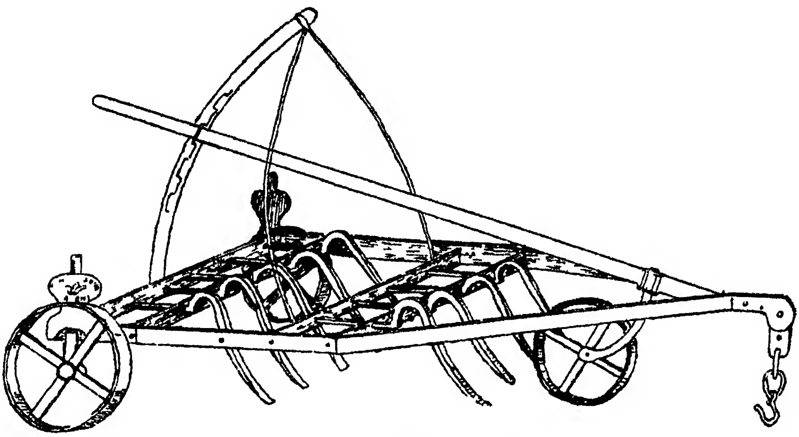

FIG 3 —Finlayson's Grubber

and patented in 1824 Finlayson's Grubber[1] (fig. 3) consisted of a framework with three wheels; it had nine rather narrow pointed tines, arranged in two rows, four in front and five behind The curvature of these had been worked out partly with the view of securing good penetration of the soil, and partly with the object of making them self-cleaning The implement could be raised or lowered on the front wheel by means of the hand regulating lever, while the level of the hind wheels was adjustable by means of screws The width between the outside tines was 5 feet 4 inches, and on ordinary land four horses were required to draw it

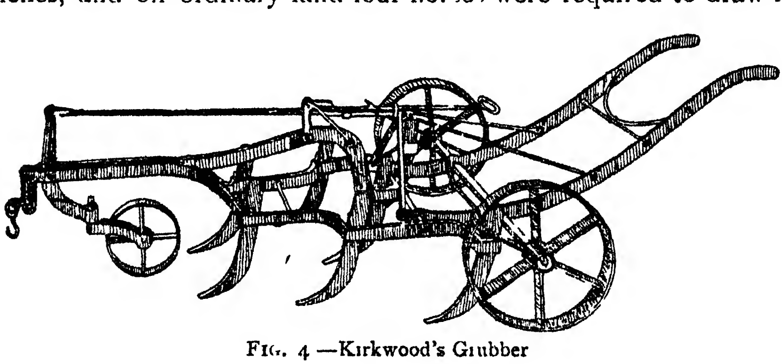

FIG. 4 —Kirkwood's Grubber

Later on the tines were made broader and chisel pointed, and were strengthened by struts from behind, also their number was reduced to five. The lifting mechanism, too, was improved.

Another early grubber which was in great repute and came into very general use was produced by James Kirkwood of Tranent. Kirkwood's grubber[2] (fig. 4) was a somewhat more complicated

[1] *Quarterly Journal of Agriculture*, vol ii (1831), p 846. [2] *Supra.*

implement than Finlayson's, provided with lever handles, by means of which the depth of the tines could be kept under continuous control. It had seven chisel pointed tines which were keyed into the frame and could thus be removed from it for sharpening. The implement figured is a slightly improved model, manufactured by Slight in Edinburgh about 1750.

The other great problem which was occupying the minds of agricultural improvers towards the middle of the nineteenth century was the application of steam power to the operations of tillage. However, no practical results were achieved until after 1850.

LIVER ROT.

I.—FORMER THEORIES ON THE CAUSE OF LIVER ROT IN SHEEP.

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THE life history of the Liver Fluke, its dependence upon the small fresh-water snail, and its relation to abnormally wet seasons are now common knowledge. Years ago, however, the origin and cause of the disease were mysteries about which there was considerable controversy and speculation. In the fourth edition of "A New System of Husbandry," by C. Varlo, Esq., published in 1774. a most ingenious theory as to the cause of rot is propounded, The author first states that the disease undoubtedly "proceeds from abundance of water; but how this water operates so as to bring on this malady is the question." He continues, "Many arguments, both verbal and written, I have heard upon the subject: one asserting that it proceeds from the sheeps taking in, with their food, worm-sprouts and dirt, which is generally thrown up in great quantities in wet weather. Others, that it proceeds from the sheeps taking in, with their food, cobwebs, which are always very predominant in wet and warm weather, insomuch that the grass is mostly covered with them." These ideas, however, he dismisses as improbable. His own theory is as follows. He points out that sheep "will bear a great deal of water, if it be proportionally mixed with salts, as appears by their living and feeding upon turnips, which are a very watery root, but then this is mixed with a proportionable quantity of salts." He further states that although the grass which grows on salt marshes is very full of water, yet sheep will never rot upon it. "The reason is," he says, "that though such grass be full of water, yet it is also full of salts, which by checking the redundancy of the water, prevents its doing of the mischief by rot it otherwise would." The mischief, according to Mr. Varlo, is brought about during the process of digestion in this manner. Food, passing into the paunch, "ferments" and "corrupts" owing to the heat, and on passing

into the smaller bowels, where there is a still greater degree of heat, the rich particles of the food "penetrate or evaporate through the skin of the bowels, in a steam or vapour, and are dispersed to different parts of the body." The water in the food, it is affirmed, gets to the bladder in the form of vapour. If there are any salts (!) dissolved in this vapour, these salts cause the skin of the bladder to open its pores, thus allowing the vapour to pass through and condense in the bladder But "should the water be of a poor thin quality, and destitute of a sufficient quantity of salts to keep it alive and active till it enters the bladder: in such case it falls upon the liver, in large drops, and . . . being in a hot situation, it scalds (as it were) and wounds the liver, under each drop of water, which soon turns to decay!"

Mr Varlo must have been very proud of his theory, because in a later paragraph he says, "When my reader sees and considers the premises attentively, it cannot but appear very plain to him, that what I have said is matter of fact." Consequently, as a logical outcome of his explanation, he proposes the use of salt as a preventive and as a cure for rot, though he admits that "many positive, bigoted people will d—n me for a fool, for pretending to cure the rot in sheep . '

To us it is an extraordinary thing that no mention should be made of the fluke as an active cause of the rot Indeed, on diving further into the writings of the last 150 years, we find that it is not until comparatively recently that any importance was attached to the obnoxious flat worm Cobbett had not the least idea what a fluke really was We find him, in 1825, defying anyone to explain "what causes flounders, real little flatfish, brown on one side, white on the other, mouth sideways, with tails, fins and all, leaping alive, in the inside of a rotten sheep's, and of every rotten sheep's, liver?"[1]

If the theories regarding the cause of rot were unconvincing 150 or 100 years ago, they were not much more scientific at the time when our premier agricultural society was formed There is an interesting discussion on rot and its causes in the first number of the *Journal of the Royal Agricultural Society of England*, which was published in 1840 The discussion is to be found in "A Practical Essay on the Diseases of Sheep," written by Henry Cleeve, who received a special prize of ten guineas from the Saffron Walden Agricultural Society. There had been terrible outbreaks of liver rot in sheep during the disastrous seasons of 1816, 1817 and 1830—over one and a half million sheep, valued at £4,000 000 dying in the last-mentioned year—so that it is quite natural for the author of the essay to discuss the cause of the malady at considerable length.

Again it is surprising to find very little importance attached to the presence of flukes in a rotted liver. The author says, "These flukes are by some considered the cause of the disease, and it has hence often been called 'the fluke.' This clearly is an error. The fluke is by some supposed to be generated by the corrupt state of the liver" In an age when mites, lice, maggots, etc. were popularly

[1] "Rural Ride: From Kensington across Surrey, and along that County." Oct 1825.

supposed to be created from dust, it was considered quite a natural thing that a decomposing liver should create "flat-fish" or "flounders." Pasteur had yet to disprove the theory of Spontaneous Generation.

According to Mr. Cleeve, "So many are the proofs that rot is produced by peculiarity of the soil, that it is not worth while to quote evidence to this effect; but the question still remains in what this fatal peculiarity of soil consists.' Apparently it was common knowledge that sheep in dry districts or on salt marshes rarely contracted rot One suggestion was that the rot occurred as a result of sheep being compelled to lie on wet ground Another, that "the rot originates in marshy exhalations" A more ingenious explanation is put forward in a footnote. Sheep are said to become rotted, not on all types of wet land, but on those soils having a bog at a depth of 8-10 feet below the surface.

"Between this subterraneous bog and the surface," continues the note, "there is generally a hard stratum of blue clay or sand, tainted with the bog water . . . and this infectious water is brought up from the bog to the surface of the earth by means of small pipes . . called by experienced land drainers, bog-pipes In consequence of this infectious water thus arising to the surface, a plant is produced—not of the grass tribe, but called by some old experienced shepherds the sheep-rot weed; and if sheep are allowed to feed on this land, particularly if in a hungry state, although the weed does not grow more than an inch or two above the surface and is of a nauseous taste, they will . . indiscriminately eat it up along with the grass, and it will, I believe, more or less infect them with the rot."

It would be interesting to know what this "sheep rot-weed" was, if indeed it existed except in the imagination of the "old experienced shepherds" It seems that the sheep-rot-weed theory is a very old one Hartlib, a friend of Milton, wrote a small treatise in 1651 in which reference was made to the sheep-rot-weed Mr. W. Youatt, however, was inclined to be sceptical about this theory. His suggestion, put forward in a further note to the essay, was that "rot in sheep is probably the produce of ground which has been lately wet, and then the surface exposed to the action of the air. The grass and other plants become decomposed or rotten, and in that decomposition certain gases or miasmata may be developed that cannot long be breathed, or scarcely breathed at all, by the sheep without producing the rot"

Sufficient has been quoted for the reader to be in complete agreement with the author of the essay when he says that (in 1839) "the rot is of all the diseases of sheep the most fatal, and perhaps, as respects its proximate cause, the least understood." He will be confirmed in his opinion on learning that other suggested causes of the disease included the feeding to sheep of turnips when covered with a heavy dew or hoar frost, and the turning out of sheep from the fold whilst the dew is on the ground!

II.—THE ERADICATION OF LIVER-ROT.

Summary of Recent Investigations.

JAS. RITCHIE, M.A., D.Sc., F.R.S.E.

THE fell disease of liver-rot still causes a large annual mortality amongst British sheep, and it is somewhat surprising that no persistent attempt has been made to find a remedy which would lead to the virtual disappearance of so grievous a burden upon the flock-master. Of course, at the present day, the incidence of the disease is by no means so heavy as it was a century and a half ago, for the more perfect draining of the land did much to check its abundance, but the fact that the disease has been allowed to continue in force without serious attempt at counter measures says little for the community's faith in the value of scientific investigation. It would have paid the farmer hundreds of times over to have employed a scientific investigator to spend his whole time and ingenuity in devising methods of combating this disease alone. There are good reasons for believing that liver-rot would have yielded to persistent attack.

It is well known nowadays that liver-rot is caused by one of the stages of a common liver-fluke which, like many of its relatives, has a complicated life-history The eggs of the fluke, passing to the open air in the excrement of the sheep, must fall near water, else the larva, which hatches in a few weeks dies It dies with equal surety if within a few hours of hatching it does not encounter in the water a water-snail, *Limnæa truncatula* or perhaps *L. peregra*, into which it bores. In the snail progressive changes take place, but if, on emerging from the snail and coming to rest upon a stem of damp grass, the juvenile fluke is not engulfed by a browsing sheep, again the life cycle comes to naught. The fluke in its life-history runs many risks, and it is clear that if at any of the critical stages the cycle is broken, the parasite's career of harmfulness is ended. The cause of liver-rot, then, is vulnerable at many different points, and experiment must decide at which point war must be waged.

Nature herself gives a useful hint In dry seasons the incidence of liver-rot in sheep is less intense than in wet seasons, the reason being that abundance of moisture, sodden fields, and extended pools or even puddles, afford opportunity for fresh extensions on the part of the water-snails, and give just the conditions which assure the safe development of the liver-fluke itself. It would seem, therefore, that a promising line of procedure would be to emulate the effect of a dry season or the result of drainage, both of which reduce the numbers of the water-snails which form a necessary link in the chain of the fluke's life-history.

Along this line of investigation valuable results have been obtained by the staff of the Department of Agriculture in the University College of North Wales, Bangor, notably by Dr. C. L. Walton, with whom has recently been associated Mr. W. Norman Jones.[1] They have attacked the snails, and with such success

[1] The most recent of several papers bearing on these experiments appeared in the *Journal of the Ministry of Agriculture* in November 1925, from which the following remarks are summarised.

that they may now be said to have attained a practical method which ought to lead to a considerable lessening of liver-rot.

The method employed was to mark out by means of numbered pegs equal plots, 36 in number, where water-snails were abundant, to treat the plots at the same time with various chemicals, and thereafter to make a count of the snails, dead and alive, on each plot. Of the different substances tested, copper sulphate, either sprayed, dusted or broadcast, proved the most effective. A few examples will indicate the measure of success attained. A plot of 25 sq. yards, consisting of soft damp mud, part of a drying pool in a grass field, with grass tufts here and there, was *sprayed* with copper sulphate in a 1 per cent. solution. From this plot 131 snails were collected, all dead; whereas on a similar plot which remained untreated, 82 snails were collected, of which 5 were dead (natural mortality) and 77 were alive In the same area a 22 sq. yard plot, *dusted* with a mixture of 1 part copper sulphate and 2 parts of china clay, yielded 114 snails, all dead; whereas in the untreated plot alongside, of 115 snails collected, 12 only were dead (natural mortality) and 103 were alive. Similar results followed from *broadcasting* with a mixture of copper sulphate and fine sand.

The authors draw the following conclusions from their many experiments. The spraying method, in which solutions of 2, 1 and ½ per cent. were all equally effective under varied field conditions, is especially suitable for damp land. It has the further advantage that the poisoning action upon the snails is very rapid, and that the risk to stock is slight. The amount of fluid varies with the conditions of moisture in the area to be treated, but in unfavourable conditions, damp soil and heavy herbage, 130 gallons an acre was used, applied with a Holder-Harridan Automatic Knapsack spray. The cost of the chemicals for such spraying with a ½ per cent. solution was approximately *7s 6d.* per acre.

Dusting with a mixture of copper sulphate 1 part by weight and china clay 4 parts by weight, is most useful for small areas, ditches, margins of ponds and the like, but the action is slower, and stock should be excluded from treated areas until rain has washed the grass clean The amounts required are about 27½ lbs of copper sulphate and 110 lbs. china clay per acre, the cost of materials working out at about *12s. 6d.* per acre.

In large swampy areas where the ground is too soft for the use of spray or dusting machines, broadcasting is best. A mixture of 1 part copper sulphate and 4 to 8 parts of fine dry sand was effective, but the mixture is best employed on wet land or before rain. It also demands the exclusion of stock until the grass is washed clean by rain. The amounts required ran to about 27½ lbs. copper sulphate and 220 lbs. sand per acre, the cost averaging about *10s.* for that area.

Dr. Walton and his colleague are to be congratulated on this promising attack against a foe which the farmer had all but accepted as implacable.

SILAGE *versus* SWEDES FOR MILK PRODUCTION.

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THE ensiling of crops is not a new practice in Scotland, but the introduction of the modern tower silo has revived the interest of the dairyman in silage as a feed for cows. This interest is intensified by the fact that climatic and soil conditions render the production of roots in certain districts a precarious proposition. High labour costs and the difficulty of producing grain at a profit have also resulted in a tendency to reduce the area of land under cultivation in many localities, and so it is becoming increasingly difficult to provide a palatable succulent feed for the winter feeding of dairy cows.

It is sometimes claimed that the use of the silo renders possible the conversion of hay and other crops that cannot be properly secured otherwise owing to weather conditions into a useful feed. This is not always a sound argument. Crops that are grown for hay are not necessarily suitable for the production of a good quality of silage, and material that is cut and put into the silo while wet will not keep well. There is not much to choose between poor hay and poor silage, especially in view of the fact that the dairy cow should receive in her winter ration a succulent roughage such as roots or silage and a dry roughage such as hay.

In investigating the relative values of roots and silage for dairy cows or any other class of live stock the work can be undertaken in several ways—as comparisons of various types of roots such as turnips, swedes and mangolds with various types of silage crops. Then they can be compared on the weight basis, the dry matter basis or the acre basis. An extensive series of trials are therefor necessary before any final pronouncement can be made on the relative feeding values of roots and silage for milk-producing cows, especially in view of the fact that the most suitable root and silage crops undoubtedly vary from district to district and perhaps from season to season. The work reported here is a preliminary investigation on the relative feeding values of swedes and a silage crop of oats, peas, beans and vetches.

Resumé of Previous Work.—The direct comparisons that have been made between silage and roots are not many. There are a number of American trials on record where maize silage has been compared with sugar beets or mangolds. It should be remembered in considering these trials that maize is undoubtedly the outstanding crop for the production of a good quality of silage, whereas roots are not as a rule grown with any great degree of success in the United States for feeding purposes. This is due largely to the two factors of climatic conditions and labour costs.

The results from the American trials have been tabulated. They are by no means conclusive, as in some cases the roots have proved the better feed for milk-producing cows, though in the majority of cases the greatest yields were obtained where silage

formed the succulent roughage. In no case was the difference in yield marked.

TABLE I.

Comparison of Maize Silage and Roots for Milk Production in American Trials.

Authority.	Increase or Decrease Compared to Silage. Sugar Beets.	Mangolds.
Thorne and Hickman (13)	+	
Emery (2)		–
Thorne and Hickman (14)	+	
Brooks (1)	–	
Waters, Caldwell and Hess (15) .. .	–	–
Waters and Weld (16)	–	–
Hills (7)...	–	
Haecker (4)	–	
Savage (12) . .		+
Trials showing increase over silage ...	2	1
Trials showing decrease from silage ...	5	3

From the trials where sufficient data were available Henry and Morrison (5) calculated the yields of milk per 100 lbs. of dry matter in the ration where sugar beets and maize silage were compared and their results are presented here. It will again be seen that in the majority of cases the silage rations gave the greatest returns in milk, though in no case were there great differences in the results obtained with the two types of ration.

TABLE II.

Milk per 100 *lbs. Dry Matter in Sugar Beet and Maize Silage Rations.*

(Henry and Morrison (5))

Station Trial.	Sugar Beet. Milk lbs.	Maize Silage. Milk lbs.
Ohio, 1889	59	62
Ohio, 1890	59	60
Ohio, 1891	62	66
Ohio, 1892	69	76
Pennsylvania	87	82
Vermont	113	119

A few recent English trials are on record where silage and mangolds have been more or less directly compared for milk-producing purposes. In comparing mangolds with oat and tare silage, Oldershaw (8) found that 60 lbs. of silage were equal to 60 lbs. of mangolds and 7 lbs. of chaff, while in a later trial Oldershaw and Smith (9) found that a ration of 60 lbs. of oat

and tare silage fed with barley straw, kale and 4 lbs. of mixed concentrates was somewhat less valuable than one of 60 lbs. of mangolds fed with the same quantity of barley straw and kale, but with double the concentrates.

It is stated by Robertson and Pitcher (11) that when 50 lbs. of oat, tare and bean silage replaced 50 lbs. of mangolds, 18 lbs. of chopped oat straw and 2 lbs. of concentrates, the production of milk was practically unaltered; while White and Roberts (17) found that oat and pea silage gave slightly superior results to mangolds where 40 lbs. of silage and 8 lbs. of mangolds were compared with 40 lbs. of mangolds and the remainder of the rations were constant.

Two comparisons of oat and tare silage with cut mangolds were made by Fishwick (3). In the first case 45 lbs. of silage, 6 lbs. of hay and 3 lbs. of oat straw were compared with 56 lbs. of mangolds, 8 lbs. of hay and 9 lbs. of straw, and the rations were found to be of about equal value. In the second trial 45 lbs of silage, 8 lbs. of hay and 6 lbs of oat straw were fed against 84 lbs. of mangolds, 12 lbs. of hay, 6 lbs of straw and 2 lbs. of Egyptian cotton cake. Here the mangold ration gave the higher yield of milk.

There are also two trials conducted by Rae and Gardner (10). In one trial 40 lbs. of mangolds and 1 lb. each of beans and oats were replaced from a ration containing 70 lbs of mangolds by 40 lbs of sainfoin silage. In the other 50 lbs. of oat, tare, bean and wheat silage were compared with 23½ lbs. of the same silage and 56 lbs of mangolds. The silage and mangolds gave very similar results in both trials.

From the trials summarised here it is not possible to fix any definite value for silage in terms of roots. It would appear, however, that the ordinary level of production of a herd of dairy cows can be maintained with either silage or roots as the succulent feed.

Experimental Outline—The feeding trial reported here was a comparison of Picton swede with a silage composed of oats, peas, beans and vetches. The swedes had been lifted and pitted while the silage was made in a Hoard silo. Eight cows were used in the trial. Information concerning them has been tabulated and, where required, the data given have been calculated to the day on which the trial started, 18th February 1925. The two cows Nos. 49 and 56 were pure-bred British Friesians, while the others were pure bred Ayrshires. All of the animals were open when the trial started

TABLE III.

Animals Used.

Cow—No. ...	7	22	24	40	47	48	49	56
Age—Years ...	4	5	8	3	3	3	3	3
Fresh—Days ...	48	62	19	94	23	24	150	15
Previous Lactations	2	3	5	1	...	...	1	...

The trial consisted of three periods of 20 days, and each period was divided into two sub-periods of 10 days. Silage was fed in periods I. and III. and swedes in period II. The allowance of swedes was 40 lbs. per cow per day, and an effort was made to

feed 24 lbs. of silage per head daily, but, as will be seen later, there was difficulty in getting some of the cows to consume this amount towards the end of the trial. As a consequence the silage was sprinkled with treacle water during the second half of the last period to improve its palatability.

In addition to the silage or roots, each cow had an allowance of 7 lbs. of mixed hay and 12 lbs. of oat straw daily until the last half of the third period, when, no straw being available, the daily allowance of hay was increased to 18 lbs. per cow.

The concentrate mixture consisted of three parts bean meal, three parts crushed oats, one and a half parts decorticated cotton cake, one part distillers' dried grains and one part wheat bran by weight, and was fed according to the production of the animals.

The amounts of hay and straw fed were controlled by occasional weighings, while the concentrates, silage and roots were weighed for each feed. The silage refused was weighed back daily. The milk was weighed and sampled at each milking, and composite samples were tested for butter fat at the end of each ten day period. One sample of the roots and two of the silage were also taken for analyses.

Results.—When the total yield of milk and butter fat obtained during the root feeding period is compared with the average yield for the two periods during which silage was fed, it is found that the roots induced a somewhat higher milk-production than did the silage. This increase is not exceptionally large, but it is perhaps significant, as every cow gave a higher yield when fed roots than when on the silage ration. There was an average increase of 7 per cent. in milk and 3 per cent. in fat yield, with a consequent decrease of 3 per cent. in fat content when the cows were fed roots.

During the first period the cows consumed the silage fairly well, the average consumption being 23 lbs. per head daily. In the final period the average daily consumption was only 20 lbs., but this decline in consumption was mainly due to the two cows Nos. 7 and 40 consuming on the average only 13 to 14 lbs. each daily. It might be considered that this refusal of the two cows to clean up their silage would alter the final results of the trial, but if these two animals be eliminated, it is found that the others still show an average increase of 6 per cent. in milk yield while on roots as compared with silage.

TABLE IV.

Summary of Milk Production.

Period No.	Succulent Roughage.	Milk Yield.	Fat Yield.	Fat Content.
		lbs.	lbs.	Per cent.
I.	Silage	4014	146·74	3·66
III.	Silage	3251	117·83	3 62
Average	Silage	3633	132·29	3·64
II.	Roots	3886	136·84	3·52
Increase over Silage—Per cent. . .		7	3	−3

TABLE V.

Summary of Silage Consumption.

Cow No.	Silage Consumed.		
	Period I.	Period III.	Total.
	lbs.	lbs.	lbs.
7	471	270	741
22	471	422	893
24	475	414	889
40	474	296	770
47	475	417	892
48	477	418	895
49	480	468	948
56	469	424	893
Total	3792	3129	6921
Average per head per day	23	20	22

TABLE VI.

Summary of Total Feed Consumption.

Period No.	Succulent Roughage.	Hay.	Straw.	Concentrates.	Silage.	Roots.
		lbs	lbs.	lbs.	lbs.	lbs
I.	Silage	1120	1920	1892	3792	...
III	Silage	2088	756	1844	3129	...
Average	Silage	1604	1338	1868	3461	...
II.	Roots	1120	1920	1899	...	6400

If the feeds other than the succulent roughages be considered, it will be found that during the root period the cows obtained slightly more concentrates than during the silage periods, but yet not enough to cause any appreciable influence on the milk yield. During the final silage period, as already mentioned, the cows had more hay and less straw than during the root period, and this would be an advantage to the silage.

TABLE VII.

Analyses of Silage and Roots.

(Analyses furnished by the Chemistry Department.)

	Silage.		Picton Swede.
	Sample I.	Sample II.	
	Per cent.	Per cent.	Per cent.
Moisture	77·57	78·00	90·17
Dry Matter	22·43	22·00	9·83
Crude Protein	2·84	3·07	0·74
Soluble Carbohydrates	9·15	8·56	7·73
Crude Fibre	8·00	7·74	0·69
Crude Fat	0·58	0·58	0·10
Ash	1·86	2·05	0·57

The silage contained on the average 77·78 per cent. of moisture and 22·22 per cent. of dry matter as compared with 9·83 per cent. of dry matter in the roots. If the silage and roots be compared on the dry matter basis, it will be found that the silage is relatively high in crude fibre and crude protein, and relatively low in soluble carbohydrates. As a silage it is somewhat low in dry matter.

The lack of palatability of this silage was probably due to its content of moisture and crude protein. A good protein content is desirable in a silage when there is a relatively high content of soluble carbohydrates present. The soluble carbohydrates are converted into lactic and other organic acids and have a preservative effect, hold putrefactive changes in check and impart to the silage a flavour and aroma pleasing to the animals. Maize is the crop that produces the most palatable silage, and Henry and Morrison (6) state that on the average maize silage contains 26·3 per cent. of dry matter, 15·4 per cent. of soluble carbohydrates and only 2·1 per cent of crude protein. The silage used in the present trial contained relatively 40 per cent. more protein and 43 per cent. less soluble carbohydrates than does maize silage. In other words, while maize silage contains 7·3 lbs of soluble carbohydrates for each lb. of crude protein, the silage used in this trial had only 3·0 lbs. of soluble carbohydrates per lb of crude protein. It had not enough carbohydrates to control the nature of the fermentative processes.

Results obtained by Wright and Shaw (18) also indicate the danger of excessive putrefactive changes when there is a large amount of protein present and a relatively low amount of soluble carbohydrates.

TABLE VIII.

Influence of Silage Composition on Protein Losses.

(Wright and Shaw (18))

Silage	Dry Matter	On Dry Matter Basis.						
		Crude Protein		True Protein		Soluble Carbohydrates	Ratio of Crude Protein to Sol Carbohs	Loss of True Protein
	In Per cent	In Per cent	Out. Per cent	In Per cent	Out Per cent	In Per cent	In 1	Per cent.
Sudan Grass	30·3	6·0	6·4	5·3	4·5	53·0	8·8	15
Sudan Grass & Soybeans ...	30·3	11·0	11·3	9·0	7·1	49·3	4·5	21
Soybeans ...	36·3	16·7	17·6	12·7	9·8	44·9	2·7	23

As will be seen from these figures, the crude protein content of the silage did not alter much from the time it went into the silo until it came out, no matter what the original protein content might be. It will be noticed, however, that the true protein suffered an appreciable loss during storage. The greater was the original content of crude and true protein and the narrower the ratio of the crude protein to the soluble carbohydrates, the greater was the loss of true protein in the silo. This loss was due to putrefaction or the breaking up of true protein into compounds which still showed up in the crude protein.

In the trial reported here the protein content of the silage was not high, but it was high relatively when the content of soluble carbohydrates is considered. The moisture content was also high, and a reduction in it with an increase in the soluble carbohydrates would have resulted in a silage of better keeping quality and improved palatability. Another factor that has to be considered is the existence of hollow stems in a large amount of the material in the mixture. With a hollow-stemmed crop it is not possible, even with good packing, to exclude all the air from the silage, and the inclusion of this promotes the growth of moulds.

The yields of milk per 100 lbs. of roots or silage and per 100 lbs. of dry matter fed have been calculated. The ration containing roots gave the most milk and butter fat per 100 lbs. of dry matter consumed, though, as would be expected, there was more milk per 100 lbs. of silage than per 100 lbs. of roots. From the table it will be seen that where a 20 ton crop of swedes can be obtained at least 11½ tons of silage per acre must be fed out of the silo before the same yield of milk can be produced. When a 30 ton root crop, not an exceptional yield, is obtained the required yield of silage would be over 17 tons per acre. It can be seen, therefore, that though silage may replace roots where these can not be grown successfully, there is little danger of silage taking the place of roots where these can be grown satisfactorily if the yield of marketable product per acre is to be maintained. Some equivalent values per ton have also been worked out for silage and roots

TABLE IX.

Equivalent Values of Swedes and Silage.

	Swedes.	Silage
Milk per 100 lbs. Dry Matter in Ration	79 lbs.	74 lbs
Fat per 100 lbs. Dry Matter in Ration	2·79 lbs.	2·68 lbs.
Milk per 100 lbs. Succulent Feed	61 lbs	105 lbs.
Equivalent Weights	1 ton. 1 ton 14 cwts	11½ cwts. 1 ton
Equivalent Yields per Acre	20 tons 25 tons. 30 tons.	11 tons 10 cwts. 14 tons 8 cwts. 17 tons 5 cwts.
Equivalent Prices per Ton	15/- 20/- 25/-	26/- 35/- 44/-

Summary.—A ration of 40 lbs. of swedes induced a 7 per cent. greater milk yield than a ration containing on the average 22 lbs. of silage. The lack of palatability of the silage used was probably due to putrefactive changes.

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Farm Wages in Winter 1925 6.

THE following article is contributed by Sir Jas. Wilson, K.C.S I.:—In a statement recently issued by the Board of Agriculture giving the rates of wages for farm labour at present prevalent in Scotland, they have, in calculating the cash value of the allowances given in addition to the cash wage, adopted for the whole country the following values:—meal, 20*s.* per cwt.; milk, 1*s.* per gallon; potatoes, £3 per ton; house, £6 per annum; coal, 35*s.* per ton; board and lodging for single men, 14*s.* per week; bothy accommodation, with attendance, £9 per annum, without attendance, £6 per annum. These rates are the same as those adopted in the similar statement for Whitsunday 1925, except that potatoes are now valued at £3 per ton instead of £4. In the statement for Martinmas 1924, potatoes were valued at £7 per ton, milk at 1*s.* 6*d.* per gallon, and board and lodging for single men at 12*s* 6*d.* a week. These changes, taken by themselves, would lead to a slight fall as compared with the valuation placed on the allowances of married men last summer, and to a considerable fall as compared with the valuation of winter 1924-5, without any change in the quantity of the allowances actually given.

As regards married men, the arithmetical averages of the statistics given by the Board (after omitting those which are not

strictly comparable), work out as follows for all the counties of Scotland put together:—

Average Weekly Earnings of Married Men.

	In Winter 1924-5.			In Summer 1925.			In Winter 1925-6.		
	Cash.	Allowances.	Total.	Cash.	Allowances.	Total.	Cash.	Allowances.	Total.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Ploughmen .	29 6	9 10	39 4	29 11	8 5	38 4	30 3	8 1	38 4
Cattlemen .	30 3	9 10	40 1	30 0	9 1	39 1	31 5	8 5	39 10
Shepherds .	29 2	10 8	39 10	30 0	9 5	39 5	30 8	9 0	39 8

According to these figures there has been in the last twelve months a small rise in the cash wages of all three classes, and a fall (accounted for above) in the cash values of the allowances, making the present estimate of the cash value of the total earnings slightly less than it was a year ago. The earnings of married cattlemen and shepherds are returned as somewhat higher than those of married ploughmen, but the ploughmen are so much more numerous that special attention may be directed to their case.

Married Ploughmen.—In most counties of Scotland the married ploughmen are engaged for a year from Whitsunday, and there no general change took place at last Martinmas in their cash wages. But in the central industrial area they are usually engaged either for a year or for six months every Martinmas, so that last November they had to make new bargains with their employers. After comparison of the information given by the Board's agricultural reporters with the information contained in the *Scottish Farm Servant* and other papers, I estimate as follows the average weekly earnings of married ploughmen in this area.—

Average Weekly Earnings of Ordinary Married Ploughmen (excluding Grieves and Foremen).

Area	In Winter 1924-5			In Summer 1925			In Winter 1925-6		
	Cash	Allowances	Total	Cash	Allowances	Total	Cash	Allowances	Total.
	s.	s.	s.	s.	s.	s.	s.	s.	s.
Stirling .	40	4	44	40	3	43	40	3	43
Dumbarton (Lower Clyde Valley) .	39	5	44	40	4	44	40	4	44
Lanark (do.)	39	5	44	40	4	44	40	4	44
Renfrew (do.)	39	5	44	40	4	44	38	4	42
Ayr (North)	38	5	43	38	5	43	37	4	41
Fife (S. W.)	40	2	42	40	1	41	40	1	41
Fife (N. E.)	30	14	44	30	12	42	30	11	41
Forfar (S. W.)	28	14	42	31	11	42	32	10	42
Perth (S. E.) .	29	14	43	29	11	40	29	10	39
Perth (Central)	27	13	40	26	11	37	27	10	37
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Average .	34 11	8 1	43 0	35 5	6 7	42 0	35 4	6 1	41 5

As indicated by these figures and by the reports on the hiring-markets, very little change has taken place during the last twelve months in the average cash rates paid to married ploughmen in these areas, the arithmetical average being 35*s.* 4*d.* a week now, compared with 34*s.* 11*d.* a year ago. The fall in the average estimated cash value of the allowances from 8*s.* 1*d.* to 6*s.* 1*d.* per week has been accounted for above.

Putting the two together, the arithmetical cash value of the total earnings comes to 41*s.* 5*d.* now, compared with 43*s.* a year ago. The pre-war earnings of married ploughmen in this industrial area were about 24*s.* a week, so that the rise in the cash value of their total earnings compared with pre-war is now about 73 per cent, compared with 79 per cent. a year ago. According to the *Labour Gazette*, on 1st February last the rise in the cost of living of an ordinary working man's family is now 73 per cent above what it was in July 1914, as compared with a rise of 79 per cent. on the same date last year. It seems, therefore, that the average married ploughman in this area can still afford to maintain his family at about the same standard of comfort as he could afford a year ago or immediately before the outbreak of war.

Single Ploughmen.—Except in the south-eastern counties, single men are generally engaged for six months at a time, and most of them had to make a new bargain last Martinmas. According to the Board's reporters the arithmetical average of their cash wages now comes to 23*s.* 10*d.* a week, compared to 24*s.* 11*d.* last summer, and to 23*s.* 8*d.* a year ago. As compared with last summer, a slight increase is reported in Aberdeen, Forfar and Perth, but a considerable decrease in the Lower Clyde Valley, possibly owing to the depression in shipbuilding and allied trades. At many of the hiring-markets hiring was slow, owing to the forward state of work on the farms at that time. Including the cash values placed on the allowances, the arithmetical average of the total earnings of single ploughmen now comes to 33*s.* 10*d.*, as compared with 34*s.* 8*d.* last summer and 32*s.* 10*d.* a year ago (when the cost of board and lodging was valued at only 12*s.* 6*d.*), but it varies from over 40*s.* a week in Forfar and Central Perth to less than 30*s.* in Wigtown, Dumfries, the West Highlands and Sutherland.

Agreements.—It was agreed between the National Farmers' Union and the Farm Servants' Union that no change should be made at last Martinmas in the current level of wages in the Glasgow area and in West Fife. No important change has been made as regards the hours of work on farms, which remain much as I stated in the October issue of this Journal. In the Glasgow area, however, by agreement between the two Unions, an important experiment was made in the method of conducting the hiring-fairs which may have a far-reaching effect. Hitherto these fairs have generally been held in the open, crowded street, in all sorts of weather, within easy reach of the public-houses, so that it was difficult for farmers and men to meet and discuss the terms of a possible engagement quietly and comfortably. At last Martinmas joint arrangements were made to secure a suitable hall, where they could meet under cover, and registers were opened in which farmers

who had vacancies to fill and workers who desired employment could enter their requirements and so be brought together to arrange their individual bargains. The experiment was fairly successful as a beginning, and is being followed up by similar arrangements in East Lothian and elsewhere.

Long Engagements.—In Scotland practically all the workers on farms, both men and women, except the merely temporary hands, are engaged for a period of a year or six months, and their engagements are renewed at every Whitsunday or Martinmas. In the November issue of the *Scottish Farm Servant*, Mr. Duncan, the able Secretary of the Farm Servants' Union, has again expressed the opinion that these long-term engagements should be abolished, and that workers should be able to leave and liable to be discharged on a week or a month's notice. I do not agree with this view, nor do I see why shorter engagements should result in greater stability of employment. They would no doubt strengthen the two Unions as against each other, and make it easier to organise a strike or a lock-out; but the change would greatly lessen the security of the farm worker, and especially of the married man. At present, when he has made his bargain for six months or for a year, he knows that, so long as he fulfils the terms of his contract he will have, until the end of the period, a house for himself and his family, constant employment whatever be the state of the weather, a fixed cash wage and allowances in potatoes, meal, milk, etc, which will enable him to provide his family with wholesome food. If he were to become liable to dismissal on a week or a month's notice, he might at any time find himself houseless and without employment, and might be discharged or have his wages cut down in slack seasons, to be re-employed or have his wages temporarily raised in busy seasons, as happens to many farm workers in England. He would be freer to change his employment when it suited him, but his employer would have similar freedom to get rid of him if he thought it advantageous to do so. He would be freer to obey the orders of his Trades Union, but he might find that a harder task-master than his farmer-employer, as it might at any time by ordering a strike require him to sacrifice the interests of his family to those of his class-mates, much against his own will and his own opinion as to what was just and right. From the farmer's point of view, too, the long-term engagement has this advantage, that he knows what his staff will be for a considerable period, and can make his arrangements accordingly without being subject to any sudden change, except at term time. There are similar advantages in the long-term engagement of single men and women workers, though they are not so great as in the case of the married man, who has the comfort and security of a wife and family to think of. I venture, therefore, to advise the farm workers of Scotland to adhere to the present custom of long-term engagements, and wherever they can, to bargain for allowances of meal, milk and potatoes as part of their remuneration. It is to be hoped that Parliament will soon pass a measure making the housing subsidy available for the repair and improvement of existing cottages, and so help to remove a real grievance of farm workers in many parts of the country.

Conditions in England and Wales.—The Ministry of Agriculture and Fisheries has recently published a report for the year ending 30th September, 1925, of proceedings under the Agricultural Wages (Regulation) Act, 1924, which renders it possible to make a rough comparison between the conditions affecting farm workers in England and Wales and those prevalent in Scotland.

Ordinary Male Agricultural Labourers.—It is estimated that in 1914 the average weekly earnings of ordinary male agricultural labourers, including the value of allowances in kind, but excluding extra earnings at harvest, were for England and Wales about 18*s.* a week, and that by the time of the passing of the Corn Production Act in August, 1917, they had risen to about 25*s.* The effect of orders made by the Wages Board established under that Act was that in summer 1918 the average minimum rate for England and Wales was about 30*s.* 6*d.*, and that it rapidly rose until in August, 1920, it was 46*s.* 10½*d.* In the following year it was reduced to 42*s.* 3*d.*, and after the Wages Board was replaced by Voluntary Conciliation Committees, the average rate in the country as a whole fell to about 28*s.* a week in 1923. Since the present Act came into force in 1924, the rates fixed by the new Agricultural Wages Committees represent advances in nearly every area, the increases ranging up to 5*s.* 6*d*, and the average of the minimum rates throughout the country is now about 31*s.* 6*d.* In Norfolk, Suffolk and Berkshire it is only about 29*s.*, and with the exception of the Metropolitan counties the minimum rate in the South of England ranges about 30*s.* In the Midlands it is about 31*s.*, and in Yorkshire and the North it is rather higher. The present average rate of 31*s.* 6*d* for an ordinary agricultural worker for the whole of England and Wales may be roughly compared with the arithmetical average of the total earnings of single ploughmen in Scotland, which now comes to 33*s* 10*d.* according to the Board's reporters, the higher rate in Scotland being more than justified by the fact that the single ploughman generally has a pair of horses to look after, while the ordinary English agricultural labourer has no such charge.

Cattlemen, Horsemen and Shepherds.—In previous reports I have estimated that for Scotland as a whole the average weekly earnings in 1914 of a married ploughman were about 22*s.* a week. The Ministry of Agriculture roughly estimates that before the war the total earnings of skilled workers such as cattlemen, horsemen and shepherds in England and Wales were equivalent to 2*s.* to 4*s.* per week more than those of ordinary workers, which would make them from 20*s.* to 22*s.* a week. The additional earnings of stockmen over those of ordinary workers are estimated to have been about 6*s.* a week in 1918, to have risen to about 9*s.* or 10*s.* a week in 1920, and now to average throughout England and Wales about 5*s.* 6*d.* per week, which would make their average total earnings 37*s.* a week. This figure may be compared with the average weekly earnings of married workmen for the whole of Scotland as given by the Board's reporters and quoted above, namely:—for married ploughmen 38*s.* 4*d.*, for married cattlemen 39*s.* 10*d*, for married shepherds 39*s.* 8*d.* But as in several areas in England the regular agricultural worker has greater opportunities of earning overtime

on harvest work than he generally has in Scotland, it seems that now there is comparatively little difference between the average weekly earnings of married ploughmen in England and in Scotland.

Hours of Work.—While the Agricultural Wages Committees in England and Wales have no power to fix hours of work, there is naturally a tendency for the number of hours specified in the orders as the basis of the weekly minimum wage to become the standard in the case of ordinary agricultural workers. It is estimated that for the country as a whole the average weekly hours for ordinary workers are about 52 in summer and 50 in winter, or an average of 51 all the year round. The conditions on this point in Scotland have been summarised in my article published in this Journal for October 1925, and it is calculated that for the country as a whole, after allowing for short days in winter, long days in harvest and holidays, including the Saturday half-holiday where that is allowed, the average hours of work on a farm in Scotland are about 50 a week, besides which the ploughman has to spend on the average about an hour a day, including Sundays, in attending to his pair of horses.

It would seem as if the Agricultural Wages (Regulation) Act had so far resulted in improving the conditions as regards wages and working hours in England and Wales, and especially in those counties in which they were unfavourable to the farm worker, and that now they are, on the average for the whole country, nearly as good as those which are prevalent in Scotland as the result of individual bargaining between employers and workers, aided in some areas by agreements made between the local branches of the National Farmers' Union and the Scottish Farm Servants' Union, but without any statutory interference. In a great part of England the farm worker is liable to dismissal on a week's notice and is not provided with a house on or near the farm, as is the married farm worker in Scotland, but it is believed that, even where the workers are on weekly engagements, in practice many of the regular workers are employed continuously by the same employer for a period of years.

The Feeding Value of Milling Offals.

THE following article is contributed by Mr. D. W. Steuart, B Sc. (Agric.):—Investigations with regard to the relative values of feeding stuffs for different classes of stock yield results which agree wonderfully well in most cases, but perhaps the most important exception to this is found in the case of wheat bran.

Kellner's experiments with fattening cattle indicated the following unit values for wheat offals compared with barley and oats:—

	Lbs. to 1 *fodder unit.*
Barley	1·0
Oats	1·2
Middlings	1·0
Fine bran	1·5
Coarse bran	1·7

Armsby obtained somewhat similar results with wheat bran; nearly 1·5 lbs. of bran would be required to constitute a fodder

unit. According to the experiments of Brunnich and Rawson (1921) in Australia, with wethers in this case, about 1·05 lbs. of shorts or 1·5 lbs. of bran would form a unit.

Most stock feeders found that the feeding value of bran was adversely affected by war-time conditions. This was due to the higher percentage of flour taken from the wheat during that period. In pre-war days the milling percentage would be about 70 per cent. while in 1918 it was 80 per cent., with the result that it required more bran to make a fodder unit. (Cox, 1918.)

Honcamp and Nolte (1920-2) showed that the feeding value of bran would vary somewhat as follows with the milling per cent. :—

Milling per cent.	*Lbs. bran per unit.*
75	1·6
83	1·7
94	2·05

A comprehensive series of experiments with wheat offals on sheep by Woodman (1923) indicates the following unit values :—

Grade.	*Lbs. to 1 fodder unit.*
Fine middlings	1·0
Coarse middlings	1·2
Ordinary bran	1·7
Broad bran	1·7

It will be noted that broad bran showed no higher feeding value than ordinary bran. Thus we find that experimenters are agreed that it requires from 1·5 to 1·7 lbs. of bran to replace 1 lb. of barley in the rations of fattening sheep or bullocks.

With regard now to pigs—Fjord in Denmark (1889-92) found that 1·4 lbs. of bran was not sufficient to make a unit—at least 1 5 lbs. would have been required.

In the case of milk cows, however, quite other results have been obtained. In Denmark (1892-4) bran was found to be almost equal to a mixture of oats and barley in feeding value. In Sweden some eight tests (1908 12) indicated that only about 1·2 lbs. of bran were required to constitute a fodder unit.

In the case of working horses, in Sweden (1910-2) it was found that when bran formed not more than one-third of the grain ration, it was equal in feeding value to oats, i e 1·2 lbs per unit. Thus in the case of cows and horses it has been shown that only 1·2 lbs. of bran were required to constitute a fodder unit

Since the war (1923-4) the value of Swedish bran has been tested against ground oats in the feeding of cows, and the results of the experiments are reported by Professor Nils Hansson in Swedish Report No. 273, which is summarised below.

The average composition of the brans is as follows :—

	Water	Protein.	Fat.	Carbo-hydrates.	Fibre	Ash.	Digestible Proteid.
Wheat Bran -	13·5	15·0	4·1	53·2	9·0	5·2	11·3
Barley Bran -	12·3	10·3	4·7	54·9	12·2	5·6	5·8 %
Oat Bran -	8·5	7·6	3·3	54·2	20·5	5·9	4·6 %

Wheat bran has been found very suitable for cows and horses but less suitable for fattening pigs. For the first-named animals 100 lbs. of bran contains 80 fodder units, corresponding to 1·25 lbs. per unit. But in some cases it will require 1·3 lbs., or exceptionally, in the case of drastic milling, 1·4 lbs. to 1 unit. Wheat bran has a somewhat lower milk-producing value than ground oats, but as it has a favourable effect on the fat percentage the total yield of butter fat is practically the same.

In the case of fattening pigs at least 1·5 lbs. of wheat bran are required to 1 unit, and it has an unfavourable influence on the firmness of the flesh and on the carcase weight. These remarks apply equally to rye bran. Barley bran is a suitable food for pigs; the effect on the flesh is favourable, but the carcase weight shows a slight adverse effect. To 1 unit 1·2 lbs. are required. In some samples the fibre is higher than that shown. When the fibre reaches 20 per cent. then 1·4 lbs. are required per unit.

Oat bran, a bye-product from oatmeal production, is a bulky food most suitable for work horses and cattle, but it should be limited to 25 or 30 per cent of the concentrates mixture. It is less suitable for swine. Of this 100 lbs. contains 54 or 55 units; or 1·8 lbs. per unit To make it more suitable for pigs it can be mixed with rice meal A mixture of 60 per cent. oat bran and 40 per cent. rice meal when tested required 1·5 lbs. to 1 unit

Brans being relatively bulky foods the quantity fed should be limited. They should never form more than 30 or 40 per cent of the meal mixture, and in the case of fattening pigs the limit would be still lower

> *N.B*—The higher feeding value of bran (1·2 to 1·4 lbs. per unit) would apply to cows, horses and probably sows, the lower one (1·5 to 1·7 lbs. per unit) to fattening pigs, sheep, bullocks and probably poultry

THE following article is contributed by Messrs. A. C M'Candlish, M S A, and A. M'Vicar, B Sc.:—

Home and Foreign Beans for Milk Production.

Bean meal is a very popular feed for use with dairy cattle Many farmers use their own beans for the production of the meal, though the majority must purchase it. Not all of the bean meal distributed is from home-grown beans, as there are on the market many types of foreign beans which are used in the manufacture of bean meal for feeding purposes. There is little information available regarding their relative feeding values, and the prices asked for the different varieties of foreign beans do not bear any definite relationship to the market price of home beans. In view of these facts two series of trials have been conducted to determine the relative values of some of the foreign beans as compared with the home beans.

Beans Used.—In 1924 China beans were compared with the home bean, while in 1925 the white Rangoon or white Burma bean was used The home beans in each case were of good quality, as were the Rangoon beans, but the China beans contained a con-

siderable amount of peas and vetches. The meals obtained from both the China and Rangoon beans were dusty. The red Rangoon bean is at times poisonous owing to the presence of prussic acid, but the white Rangoon beans used were found by the Chemistry Department to contain only ·011 per cent. of prussic acid—an amount too small to be of any significance.

The meals showed no marked differences, in composition, with the exception that the meal from the white Rangoon beans tended to be higher in soluble carbohydrates and lower in other nutrients than the other meals.

TABLE I.

Composition of Bean Meals.

(Analysis furnished by Chemistry Department.)

Year	1924.		192	
Bean	Home.	China.	Home.	Rangoon.
	per cent.	per cent.	per cent.	per cent.
Moisture	13·65	13·16	13·25	12·35
Crude Protein	23·93	25·07	25·29	21·27
Soluble Carbohydrates	52·20	49·78	50·59	57·36
Crude Fibre	5·66	7·10	5·79	4·13
Crude Fat	1·33	1·33	1·55	1·12
Ash	3·23	3·56	3·53	3·77

Outline of the Trials.—The trials in both 1924 and 1925 were conducted at Holmes Farm, Kilmarnock, and Claunch, Sorbie. At Holmes Farm each trial consisted of three experimental periods of twenty days each with transition periods of ten days each preceding them, while the trials at Claunch were of the same duration with the exception that the transition periods were only of five days each.

In each trial there were two lots of cows. At Claunch there were always five grade Ayrshires per lot. At Holmes Farm there were five pure-bred Ayrshires in each lot in 1924, while in 1925 there were three pure-bred Ayrshires and two pure-bred Friesians in one lot and one less Friesian in the other.

The feeding was conducted by the double reversal method. The milk of each cow was weighed and sampled and the composite samples were tested for butter fat by the Gerber method.

The Rations Fed.—The daily roughage ration at Holmes Farm in 1924 consisted of 28 pounds of swedes, 12 pounds of silage, eight pounds of ryegrass and clover hay and 14 pounds of oat straw, while in 1925 the same allowance of hay and straw was given along with 20 pounds of swedes and 15 pounds of silage. The silage was composed of oats, peas, beans and vetches. At Claunch the roughage ration in each trial was 60 pounds of swedes, 8 pounds of mixed lea hay and 6 pounds of oat straw daily.

The concentrate mixture was fed in accordance with the production of the animals. At Holmes Farm the mixture used throughout was four parts bean meal, three parts ground oats, one part distillers' dried grains, one part wheat bran and two parts cottonseed meal. The mixture used at Claunch was the same

with the exception that linseed cake replaced the cottonseed meal. In all trials the meal from home-grown beans was used in the check periods and the meal from foreign beans in the others.

The Results.—The roughage ration within each trial was kept uniform. There were slight variations in concentrate consumption from time to time, but in no trial did the average variation from period to period exceed one per cent. Consequently the only changes of note that occurred in the feeding were those brought about by replacing the home bean meal with meal from another source.

TABLE II.

Average Daily Production per Cow.

	Home Beans.		Foreign Beans.		Increase.	
	Milk.	Fat.	Milk.	Fat.	Milk.	Fat.
China Beans, 1924—	lbs.	lbs.	lbs.	lbs.	%	%
Holmes Farm - -	29·9	1·09	29·4	1·11	-2	1
Claunch - - -	32·7	1·13	32·3	1·12	-1	-1
Average - -	31·3	1·11	30·8	1·11	-1	0
Rangoon Beans, 1925—						
Holmes Farm - -	25·4	0·87	25·7	0·89	1	2
Claunch - - -	28·3	0·99	28·9	1·01	2	3
Average - -	26·9	0·93	27·3	0·95	2	2

All of the bean meals were quite palatable. There were no marked changes in production brought about by the various meals, and the similarity in feeding value of the meals is emphasised by the fact that the slight changes which did occur were not uniform from lot to lot in any one trial.

On the whole, therefore, it may be said that the meals from the China and white Rangoon beans are of the same value for the feeding of dairy cows as the meal from home-grown beans. Consequently the one obtainable at the lowest price per ton should be used.

Reviews.

The Story of the Women's Institute Movement, by J. W. Robertson Scott (The Village Press, Idbury, Kingham, Oxon., 1925, price 6*s.* 6*d.*)—It is now more than ten years since the first women's institute was formed in England, and nearly nine since the first Scottish institute was formed. Mr. Robertson Scott has done a valuable piece of work in recording the early history of the movement, and his book deserves a wide circulation. Personal acquaintance with many of the leading figures and access to records have given him material for a full and lively account of the various stages through which the institutes have passed on their way to their present status in the countryside of Great Britain. Naturally England receives most of the space, two chapters being

devoted to Wales and two to Scotland. But Scotsmen are mentioned early in the story. Sir Robert Greig, who, before his appointment to the Board of Agriculture for Scotland, acted as an Inspector of Agricultural Education under the English Board of Education, wrote for that Department a report (issued in November 1912) on Agricultural Education in several Continental countries, in which he strongly urged the formation in Great Britain, after the example of Canada, Belgium and Poland, of women's institutes, "the case for which has seldom been more effectively stated." Next year he arranged for the translation by Miss Nora Hunter of Monsieur Paul de Vuyst's book, "Women's Place in Rural Economy," to which Sir Robert Wright contributed a preface.

Women's institutes had existed in Canada since 1897, and it was a Canadian, Mrs. Watt, who, at a meeting in London on 11th February 1915, gave the first impulse towards their formation in England. Mr. Nugent Harris, who was the General Secretary of the Agricultural Organisation Society, took up the scheme with enthusiasm, and it was carried on as one of that Society's activities until October 1917, when the work was transferred to the Women's Branch of the Food Production Department of the Board of Agriculture and Fisheries. There were at that time 137 institutes in England and Wales. In May 1919 another change took place, the institutes being set free from official control, except that which is made necessary by the receipt from the Development Fund of an annual grant, which, diminishing year by year, will shortly disappear.

Mr. Scott's account of these transactions does not err on the side of reserve. He is exceedingly frank in his disclosure of the "rumpuses" (as he calls them) that marked the period when Mr. Harris was pushing the institutes against the wishes of most of the governors of the Agricultural Organisation Society; of the "vain wooing" of the institutes by the Village Clubs Association; and of the differences in policy and outlook shown by various early leaders of the movement. He is eminently successful in recalling to us that mood of exasperated enthusiasm and elastic finance in which so many schemes were carried on towards the end of the war. But he is equally appreciative of the sound guidance under which the movement was at once expanded and consolidated, until in September 1925 there were in England and Wales 3383 institutes, with a membership of over 200,000

Scottish readers will turn with interest to the concluding chapters dealing with their own country. The early work of Mrs. Blair and Mrs. Gooch, the Conference of 27th June 1917, and the formation of the first institute at Longniddry, are all chronicled. For five years the work of development was carried on by the Board of Agriculture for Scotland, Miss Campbell being chief organiser, and when this arrangement came to an end in October 1922 there were about 230 institutes in Scotland. Here also, as in England, Mr. Scott treads on somewhat difficult ground. But as he says, "Who could take seriously a Scottish movement in which the national talent for discussion was not exercised?" We may, however, remark that he hardly does justice to the value of Miss Campbell's work in organising the movement

in its early stages and setting it on the right lines for further development.

Since October 1922 the number of institutes in Scotland has been doubled. In October 1925 there were 460, with a membership of 27,500, giving an average of 60 members to each institute. In England and Wales the number of institutes at the same date was 3380, with a membership of 205,000.[1] This gives the same average number per institute as in Scotland. Further, the number of institutes in each country in proportion to population was almost the same.[2]

The Scottish institutes differ from the English in name—the handy term "Rural" not being used in England—and in organisation. The English scheme is built on the county as a unit, while Scotland is for institute purposes divided into five "Areas." Here again Mr. Scott deals with matters of controversy into which we need not enter. Since October 1922 the Scottish institutes have been in receipt of an annual grant of £3000 from the "Corn Production Acts (Repeal) Act money," and their financial affairs have therefore been under the supervision of the Board of Agriculture for Scotland. This grant will, under the existing scheme, cease in October 1927, and the institutes will enter into full self-government and self-support.

Mr. Scott, in a useful Appendix, gives statistics showing the growth of the movement and the amount of assistance it has received from the State, lists of the earliest institutes and of office-bearers &c. It appears that the total amount of State assistance to the institutes in England up to 1925 was about £52,000, while in Scotland it was £16,400, which is considerably more in proportion to the size of the movement.

The present volume is mainly historical, as is implied in its title, and Mr. Scott has another volume in preparation to be entitled "Women's Institutes at Work and Play," in which he will describe the varied activities of the movement. The last chapter of the "Story" may be looked on as a foretaste of this second volume. It is entitled "Stories by the President of the First 'Rurals'" (Mrs. Blair).

Mr. Scott's book is published by himself at his village home, Idbury, Oxfordshire; it is printed in type of exceptional clearness, well bound, and enriched with many photographs. It is altogether a worthy memorial of what Sir Robert Greig has described, so far as Scotland is concerned, as "the most important movement in social and agricultural life for a hundred years."

Agricultural Progress: the Journal of the Agricultural Education Association.—From small beginnings—a membership of seven—in 1894, when its first meeting was held, the Agricultural Education Association has grown to be a strong representative and influential body of 400 members engaged in teaching and research

[1] This number is calculated on affiliation fees.

[2] In England and Wales there was one institute per 11,200 persons, and in Scotland one per 10,600; in England and Wales there was one member per 185 persons, and in Scotland one per 178. In this connection we may remark that the statement attributed to Mrs. Morgan on page 211 is unintelligible.

in agriculture. It is in its own development a measure of public and State interest in agricultural education and research in Britain, and indeed may claim no small share of credit for the growth of that interest.

The tale of the rise and progress of the Association is brightly and happily related by Sir Thomas Middleton in the current issue of *Agricultural Progress*, this being the third annual number of the journal of the Association.

Like its predecessors, Volume III. is a production highly creditable to the Association alike in the range of its subjects, in the thoroughly capable, scientific and yet popular treatment of these, and in both the literary quality and the outward form of the journal.

Brief references to some of the articles will indicate the variety and interest of the contents.

The place of honour is taken by an appreciative notice of Professor William Somerville, who lately retired from the Sibthorpian Chair of Rural Economy in Oxford University. The notice is accompanied by an excellent photogravure reproduction of a lifelike portrait of Professor Somerville by Mr. G. Hall Neale.

In dealing with experimental error in agricultural experiments, Mr. A. B. Bruce ends on the sane note that developments of statistical theory must be limited by practical considerations.

Dr. Ruston contrasts the measures by which we estimate success in farming—(*a*) high productivity from the community's point of view, and (*b*) financial return to the farmer, and shows by example that the relation between the two is such that, while a high gross output may not guarantee success, it is practically essential to it

A remarkably clear and simple description of the class of bodies known as colloids is given by Mr. H. J. Page, who explains their importance in the soil.

Mr. R. Boutflour emphasises the need for careful calculation and adjustment of the maintenance ration of dairy cows in relation to the additional ration fed for milk production--a subject which he has made his own and which he illustrates freely and forcibly.

The feeding of dairy cows is also dealt with in an account of an experiment conducted by Messrs. King and Duncan; Mr. J. Mackintosh describes a scheme for butter fat tests, which is intended to make known both the average percentage and the total fat produced for each lactation period; and Mr. H. T. Cranfield shows that the variation in the percentage of non-fatty solids in milk is greater than is usually supposed, and that this is specially so during the grazing period.

Mr. R. G. Baskett contributes a note on an experiment showing the beneficial results of the addition of certain minerals to the diet of breeding sows and their litters in respect of numbers and vitality of the offspring.

From results obtained over the period 1921-1925 on a large number of farms in Yorkshire, Dr. Ruston points out that poultry is the one department that has uniformly yielded a profit, and pleads for an extension of poultry-keeping to supply a bigger proportion of the home demand for produce.

Messrs. Robinson and Jones demonstrate the loss of phosphorus applied to grassland in a region of high rainfall and non calcareous soils in North Wales, where a period of eight years appears to be the limit of effect obtained from phosphatic manuring.

A note is supplied by Mr. J. G. Stewart on the agricultural survey work recently inaugurated in England by the Research Institute of Agricultural Economics. The aim of the surveys is to collect information on the economics of farm management, taking account of markets, prices, transport, organisation of labour and the general welfare of the labourer. It is expected that much information will also be obtained on successful methods not generally known, peculiar local problems, incidence of disease, and other matters of interest to the farming community.

New developments in agricultural education are dealt with in a series of short articles descriptive of—

(1) The National Institute for Research in Dairying.

(2) The Institute of Animal Pathology at Cambridge.

(3) The National Poultry Institute.

(4) Additions to the School of Agriculture at Cambridge, to the Departments of Agriculture Leeds University and University College of North Wales, Bangor, and to the Farm Institutes at Reaseheath, Cheshire, Moulton, North Hants; and Sparsholt, Hants

(5) A new residential college on Danish Folks high school lines—at Avoncroft, near Offenham, in the Vale of Evesham.

(6) Scholarships connected with agricultural training, including those provided by the Ministry of Agriculture and the Board of Agriculture for Scotland, the Colonial Office, and from the United Dairies Scholarship Fund of £30,000.

Papers read in the Agriculture Section (M) at the Southampton meeting of the British Association and the discussions thereon are summarised, and similar notices are provided for the Conference of Agricultural Organisers held at Oxford in April 1925, and the proceedings of the Agricultural Education Association at their meetings in Reading in July and at London in December

The journal also contains a series of reviews of books and another of notices of bulletins on agricultural subjects.

It is published by Messrs. Ernest Benn, London, and the price of the issue is 5*s*.

Publications of the International Institute of Agriculture.—Attention has been directed in previous issues to certain publications of the International Institute of Agriculture, and the following can also be recommended to all interested in agriculture, whether as producers or consumers or as students of political economy. The *International Crop Report and Agricultural Statistics* is issued monthly, and contains full information on the world production, trade and prices of the principal agricultural products; subscription rate, 10*s*. per annum. The *International Review of Science and Practice of Agriculture* is a quarterly relating to progress in agricultural science and research, live stock improvement, plant diseases, &c., in various countries; subscription rate,

12*s.* per annum. The *International Review of Agricultural Economics* is published quarterly and deals with agricultural co-operation, insurance, credit, social conditions, land systems and other agricultural economic questions; subscription rate, 8*s.* per annum. These three periodicals may be purchased from the Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W. 1, at the combined subscription rate for 1926 of £1, 5*s.*

Egg-Laying Test.

THE Board of Agriculture for Scotland recently published a report on the first egg-laying test held by them at Seafield, Roslin, Midlothian, during the period from 15th October 1924 to 15th September 1925.

The pens of pullets were accommodated separately in houses, each giving floor space of 6½ square feet per bird. A separate run is provided for each pen, and allows 25 square yards per bird.

The houses are built of seasoned white wood of good quality, 4½ inches by ⅞ inch, and the dimensions are: 8 feet long by 5 feet wide, 6 feet 9 inches high at the front and 5 feet 6 inches at the back. They are fixed on stobs 2 feet 6 inches long, driven 18 inches into the ground. In each house there are fitted 4 nests, with "Halsall" trap fronts, a moveable droppings board, a dry mash hopper, a moveable perch and an egg-box. Provision is made for adequate front and floor light and for thorough ventilation. A water dish is fitted into a covered box attached to the outside of each house.

The ducks were accommodated in a well-ventilated house 90 feet long, 12 feet wide, 5½ feet high at the sides and 9 feet in the centre. The house is provided with specially-designed wire pens, fitted with "Halsall" duck-trap fronts—one for each bird—in which the ducks are kept and fed at nights with food placed in individual dishes, which ensures that each bird gets its proper ration. The duck run consists of fully 2¼ acres of grassland divided into two parts, so that a change of run can be given when required. The birds have easy access to a dam in a burn bordering the ground.

The Board received 167 applications for entries of pens of pullets, and 18 applications for ducks. Out of these the pullet entries were reduced to 100 by ballot. These numbers were subsequently further reduced, after examination by the veterinary referees, to 67 pens of pullets and 18 pens of ducks. Each pen consisted of six birds hatched in 1924, the property of, and bred from stock the property of, the competitor. The pens were divided into six sections as follows:—

1.	White Leghorns	34 pens.
2.	White Wyandottes	9 „
3.	Rhode Island Reds	13 „
4.	Non-sitters other than White Leghorns	7 „
5.	Sitters other than White Wyandottes and Rhode Island Reds	4 „
6.	Ducks	18 „
	Total	85 „

The daily rations fed to the pullets were:—

Morning.—About 1¼ oz. per bird of grain buried in the litter. This consisted of equal parts of finely-kibbled maize, wheat, and oats during mild weather; 2 parts of finely kibbled maize to 1 part each of wheat and oats in cold weather.

Afternoon.—About 1⅝ oz. (dry weight) per bird of wet mash, consisting generally of 2 parts bran, 4 parts thirds, 2 parts maize meal, I part Sussex ground oats, 1½ parts fish or meat meal and ½ part ground lucerne (alfalfa)—all parts measured by weight. During the moulting period a sprinkling of crushed linseed was added. In cold weather the proportion of maize meal was increased, and latterly, owing to the difficulty in procuring a good quality of broad bran, the percentage of bran was reduced and that of thirds increased.

The dry mash hoppers were opened when the wet mash was fed in the afternoon and closed when the grain was fed in the morning, the mash provided being very similar in composition to the wet mash. It was found that when the birds were in full lay the quantity of dry mash consumed amounted to about 1¼ oz. per bird.

The duck rations were:—

Morning.—About 2 oz. grain composed of equal parts kibbled maize, wheat, and oats in mild weather, and 2 parts kibbled maize to 1 part each of wheat and oats in cold weather.

Afternoon.—Wet mash. About 2¼ oz. (dry weight), consisting of 2 parts bran, 4 parts thirds, 1¼ parts Sussex ground oats, 1¼ parts maize meal, and 1½ parts fish meal—all parts measured by weight. During the moulting period a sprinkling of crushed linseed was added.

The following table shows the number of pullets and ducks in the test, the number of eggs laid, the cost of food and litter, and the return for eggs:—

Number of birds at Test.	*Total Cost of Food and Litter.*	*Cost of Food, Litter, and Grit per Bird.*	*Number of Eggs laid.*	*Return for Eggs.*
Pullets, 402 Ducks, 108	£306	3*d.* per week.	89,217	£913

The system of grading eggs was as follows:—

During the first period of the test a first-grade egg was required to weigh not less than one and seven-eighth ounces; during the second period one and fifteen-sixteenth ounces; and during the remainder of the test not less than two ounces. The minimum weight for a second-grade egg at every stage of the test was a quarter of an ounce less than the above weights. Any eggs below these weights were included separately in the published records of the test, but were not included in the score total on which the awards are based. Second-grade eggs were accepted as of equal value to first-grade eggs, but not more than 120 were credited to the score of any pen; for ducks, no egg weighing less than two ounces at any period of the test was credited to the score of any pen.

The egg production, numerically, is regarded as highly satisfactory. An excessive proportion of the eggs laid during the

whole period of the test was, however, below the standard fixed for first-grade eggs. This would appear to indicate that breeders have paid more attention to breeding for the number of eggs than for their size. The total egg production of the various grades was as follows:—

	First Grade.	*Second Grade.*	*Under Weight.*	*Total.*
Hen Eggs ...	47,547	23,646	2,084	73,277
Duck Eggs ...	15,716	..	224	15,940

This represents an average number of hen eggs of 187·68 per bird, and of duck eggs 150·34 per bird. The total weight of eggs laid of all grades was:—

Hen Eggs ...	9,316 lb	6 oz.	6 dr.
Duck Eggs ...	2,485 „	6 „	6 „

an average per bird of 24 lb. for hens and 23·6 lb. for ducks In calculating the averages, allowance is made for deaths

The following special performances may be mentioned:—

White Leghorn, Pen No. 3, returned a score value of 1,316 eggs—the highest score value in the test. The total egg yield was 1,196 first grade, 182 second-grade, and 4 under weight

Rhode Island, Pen No 73, which had a score value of 1,269, laid the largest number of first-grade eggs in the pullet classes, viz. 1,211 eggs. In addition it laid 58 second-grade eggs and 2 under weight.

White Runner Duck, Pen No. 11, the winner in the duck section, laid the largest number of first-grade eggs in the test, viz. 1,220. The total egg yield was 1,270.

Agricultural Scholarships for the Sons and Daughters of Agricultural Workmen and others.

UNDER section 3 of the Corn Production Acts (Repeal) Act, 1921, provision was made for the institution of a special fund for promoting agricultural development, "including the establishment of scholarships and maintenance grants for the sons and daughters of agricultural workmen and others."

From this fund a sum of £15,000 was set apart for the purpose of these scholarships during the five years 1922-26 inclusive.

The following table shows the numbers of scholarships of the various classes awarded up to the present:—

Types of Scholarships.	Number of Scholarships awarded.				
	1922	1923	1924.	1925.	Total.
Degree Course	3	4	8	6	21
Diploma Course	3	3	5	8	19
Certificate Courses	6	6	9	7	28
Short Courses of Instruction	9	18	3	8	38
Total	21	31	25	29	106

This year scholarships of four types are again to be awarded as shown below. The number of scholarships to be awarded in each class will depend upon the number of suitable applications received.

Class I. Short Course Allowances, not exceeding 35*s.* per week for the period of the course, which will enable the holders to attend short courses of from four to ten weeks' duration in agriculture, horticulture, dairying, poultry-keeping, &c.

Applicants should be at least 16 years of age, and must have been engaged for at least a year in work of an agricultural nature.

Class II. Certificate Course Scholarships, each not exceeding £30 in value, which will enable the holders to attend courses of instruction in agriculture, horticulture, dairying, poultry-keeping, &c. These courses as a rule require attendance at classes during one session of about 20 weeks

Applicants should be at least 17 years of age, and must have been engaged for at least a year in work of an agricultural nature.

Class III. Diploma Course Scholarships, each not exceeding £120 in value, or £40 per session, which will enable the holders to attend the courses of instruction for diplomas awarded by Agricultural Colleges in Scotland. These courses as a rule require attendance at classes during three sessions of about 20 weeks each.

Applicants should be at least 17 years of age and must have gained the Intermediate Certificate of the Scottish Education Department or reached a similar standard of education, and must be prepared to sit a preliminary examination, if required.

Class IV. Degree Course Scholarships, each not exceeding £360 in value or £120 in any one year, which will be tenable while students attend courses of instruction for the degree of B Sc. (Agriculture) of a Scottish University during three academic years or thereby, or for the qualification of M.R.C V.S. at the Edinburgh or Glasgow Veterinary Colleges, which extend over four sessions

Applicants for scholarships in respect of the degree of B.Sc. (Agric.) must be in possession of the Higher Leaving Certificate of the Scottish Education Department or a similar Certificate, which qualifies them for entrance to a University, and to the course for which application is made.

Applicants for scholarships in respect of the qualification of M.R.C.V.S. must be in possession of the Intermediate Certificate of the Scottish Education Department or a similar Certificate, which qualifies them for entrance to the course of instruction. Applicants should be at least 17 years of age.

In addition to the allowances described above, class fees will be paid in respect of all scholarships awarded. Travelling expenses may be paid either in addition to, or wholly or partly in place of, the allowances.

It should be particularly noted that the sum which may be

awarded in each case is a maximum, and that within these limits assistance will be given only to such an extent as is necessary to supplement private resources.

Benefits under the Scheme are confined to:—

(*a*) The sons and daughters of agricultural workmen;

(*b*) The sons and daughters of other rural workers, including smallholders, whose financial circumstances are comparable to those of agricultural workmen;

(*c*) Persons who are themselves *bona fide* workers in agriculture, or its allied pursuits, whose financial circumstances are comparable to those of agricultural workmen.

In considering applications under category (*c*) above regard will be paid to the financial circumstances of the parents or guardians.

All applicants must be British subjects and resident in Scotland. They must intend to take up an agricultural or allied pursuit after receiving the training covered by the award.

Applications for scholarships should be made on the prescribed forms, which will be supplied by the Board on request, and which should be forwarded to the Clerk to the Education Authority for the area in which the applicant resides not later than 30th April 1926. Applications submitted after this date cannot be considered.

Fuller particulars of the Scheme may be obtained from the Secretary to the Board of Agriculture, York Buildings, Queen Street, Edinburgh.

Grants for Land Drainage

DURING the past five winters beginning 1921-22 the Board o Agriculture for Scotland have administered a scheme for the relief of unemployment under which grants have been made to landlords and farmers in aid of land drainage and improvement (including farm roads and water supplies) For the first four years the maximum grant offered was at the rate of one half of the cost of the work, but during the past winter (1925-26) the maximum rate of grant was reduced to 30 per cent. of the cost. An important condition of the grant was that approved work should be carried out chiefly by means of unemployed labour obtained through the Labour Exchange, or, failing that, by unemployed men engaged direct by the farmer, of whom at least 75 per cent. should be ex-service men.

The results of the operation of these unemployment schemes during the five winters may be summarised as follows:—

Year.	*Amount of grants paid.*	*Approximate area drained.* *Arable.*	*Pastoral.*
		Acres.	Acres.
1921-22	£14,773	3,300	47,000
1922-23	£38,621	6,500	260,000
1923-24	£32,048	4,300	253,000
1924-25	£29,664	5,300	136,000
1925-26	£16,500 (offered)	7,070 (estimated)	248,500 (estimated)

As part of the agricultural policy of the Government, the Board

have been authorised, subject to the necessary funds being voted by Parliament, to provide during the five years beginning 1st April 1926, financial assistance for agricultural drainage, including field, hill and arterial drainage, and such operations incidental to approved drainage as the removal of trees, hedges, whins, &c. The grants to be offered by the Board will not exceed one-third part of the cost of the work approved by them, or in the case of tile drainage a maximum payment of £6 per acre of land improved, whichever of these amounts be the less. While labour should if possible be obtained through the Labour Exchange and a preference given to married and ex-service men, it is not, as was the case in the previous unemployment schemes, a condition of the payment of the grant that the work should be carried out mainly by unskilled men out of employment

As the funds at the Board's disposal for each of the five years up to 1930 will be strictly limited, applications will be dealt with in such a way as to spread the benefits of the scheme, so far as practicable, equitably over the whole of Scotland, on the basis of agricultural importance and requirements. Regard will also be paid to the priority of receipt of applications.

Export of Potatoes, Plants, &c.

THE following is a summary of recent regulations issued by foreign countries with regard to the importation of potatoes, plants, &c.:—

(1) *Spain and Canary Islands*—The regulations of the Spanish Government require that living plants, potatoes, &c must be accompanied by an official certificate of health stating that they are free from plant diseases and insect pests. The term "living plants" includes parts of living plants, their branches, shoots, vine shoots, seeds, roots, tubercles, bulbs, rhizomes, leaves, &c.

(2) *Poland.*—Consignments of potatoes must be accompanied by two copies of an official certificate stating that the potatoes are free from wart disease (*Synchitrium endobioticum*, Percival). The potatoes should be in new, unused sacks.

Trees, shrubs, seedlings and cuttings may be imported on condition that the consignments are accompanied by two copies of an official certificate stating that (1) they are free from *Phylloxera vastatrix* (Planch) and its eggs and from *Schizonoura lanigera*, Hausm (Woolly Aphis or American Blight), and (2) they originate from a place which is free from these pests

The Board of Agriculture for Scotland will be glad to arrange for the inspection of consignments of potatoes, plants, &c. destined for export to these countries. The fee for inspection and the issue of the required certificate will be at the rate of £2, 2*s.* a day with a minimum of £1, 1*s.*

The following particulars should be furnished to the Board by prospective consignors :—

(*a*) When and where the consignment may be examined.
(*b*) Number of packages in the consignment.
(*c*) Distinguishing marks (if any) on packages.

(*d*) Contents of each package.
(*e*) Grower and place of origin.
(*f*) Name and address of consignor.
(*g*) Name and address of consignee.

Grants in aid of Agricultural Shows.

SINCE 1912, except for a period during the war, the Board of Agriculture for Scotland have administered a scheme for assisting agricultural shows in the crofting counties of Scotland. This scheme was instituted by the Congested Districts Board in 1909, prior to which the crofters in the outlying districts of the northern and western counties had no such means of comparing their stock or of ascertaining in this way what were the important characters that rendered one animal more valuable than another of the same class. In these districts there are few auction marts or fairs at which the higher prices paid for superior stock would produce an educational effect.

Assistance is given only to those shows at which there are classes confined to small farmers' stock, the term "small farmer" meaning occupiers of land of not over £100 rental or 100 acres in extent. The Board's grants take the form of a proportion of the prize money awarded, and in some cases part of the cost of the permanent equipment In addition, with the object of encouraging small farmers to keep promising breeding animals, special prizes are given in the cattle and horse classes. Keen local interest is shown by the small farmers, and the holding of these shows—which have increased in number from six in 1909 to 37 in 1925—has engendered a spirit of friendly rivalry among small stockowners in various districts. The reports of the judges who have attended the shows indicate a steady progress from year to year in the quality of the animals exhibited, whilst an improvement is also noted in the quality of the general stock of the districts, apart from the competing animals. The shows subsidised in 1925 were held in Argyll (4), Inverness, Skye (3), Outer Islands (2), mainland of Ross (6); Lewis (1), Sutherland (2), Caithness (2), Orkney (10), and Shetland (7).

Two years ago the scheme was extended to include agricultural shows outwith the seven crofting counties at which there are classes confined to small landholders. The term "small landholder" includes all occupiers of land not over £50 rental or 50 acres in extent. Thus grants have been awarded to shows held in the counties of Berwick, Bute (Arran), Fife, Forfar and Linlithgow.

Agricultural Conditions.

DURING the month of December and the first week of January there were heavy falls of snow throughout the country and outdoor work was practically suspended in most districts. The remainder of January was generally mild and open with frequent falls of rain, but lea ploughing and other farm work proceeded satisfactorily in the north and west; in the eastern districts, however,

and throughout the western islands, little outdoor work was accomplished during January. Mild but unsettled weather continued during the first three weeks of February; in the northern districts the rainfall was moderate and fair progress was made with farm work, but in most of the eastern and southern counties the weather was mainly wet, and cultivation was much interrupted until the last week or ten days of the month, when conditions improved. The reports regarding the state of seasonal work at the beginning of March varied considerably, but it would appear that, except on a water-logged land, ploughing was fairly well advanced for the time of the year. Little progress had been made with the planting of early potatoes, however, and dry bright weather was urgently required for the completion of spring work.

Good progress had been made with the sowing of wheat at the end of November, but owing to the unfavourable conditions that prevailed during December, January and February, the work was considerably in arrear on many farms and some sowing was carried out as late as the last week in February. The plant has been slow in brairding, and at the beginning of March was less forward than usual, but despite adverse conditions the crop shows quite a healthy appearance. In South-West Perth the braird is said to be patchy on wet land where it has rotted out, while from South-West Forfar it is reported that in some cases it has lost colour owing to the frequent rains. No actual statistics of the acreage sown are yet available, but, according to preliminary estimates made by the Board's Crop Reporters, it would appear that in many counties there will be some diminution in the area under wheat this year.

The stocks of the potato crop of last season are generally reported to be in good condition. In most districts the tubers are stated to be sound and keeping well and comparatively little disease or damage by frost has been reported. In a few cases, however, complaints have been received that amongst certain varieties an unusually large proportion of the crop was soft when taken from the pits.

In the Lowlands and on arable farms ewes wintered fairly well, and at the end of February were in fair or average condition, while the reports from the western islands indicated that the ewes had wintered better than for some years past. Hill ewes, however, suffered more or less severely from the storms of snow and rain, which have left them generally in rather a lean and bedraggled condition. Lambing began in February among special flocks in several districts and the results to date are quite satisfactory. In Berwick, North-West Lanark and South-West Forfar the fall of lambs has been above the average, while in South-West Perth twins and triplets are reported to be more numerous than usual. Elsewhere the crop is estimated to be fully up to the normal.

Turnips are reported to be plentiful in most eastern districts and in Argyll and Lanark; elsewhere the supplies will probably prove to be sufficient for the season, except in Berwick, Ayr and Dumfries, where stocks are becoming exhausted. The crop is generally in good condition, but complaints of rotting have been received from Central and North-East Aberdeen, Dumfries and

Wigtown. Damage generally has occurred in the case of unstored turnips; on high ground the crop has been injured by frost, while from East Aberdeen it is reported that a larger number than usual of the roots have been destroyed by crows and wood-pigeons.

The supply of labour appears to be sufficient generally and in some districts is in excess of present requirements. Regular workers are somewhat scarce in Kincardine and South-West Perth, while in Sutherland the supply of casual labour is rather limited and expert drainers are required in Wigtown.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions. Full references to the original publications may be obtained on application to the Secretary, Board of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Inheritance in Wheat An "Unfixable Wheat" (Investigations on the late M. Philippe De Vilmorin's "Race de Blé Nain Infixable"). *F. L. Engledow, M.A., Plant Breeding Institute, Cambridge, and S. M. Wadham, M.A., Botany School, Cambridge, Journal of Genetics, Vol. 16, No. 1, November* 1925.—Messrs Engledow and Wadham discuss the breeding experiments they carried out with an "Unfixable Wheat." Vilmorin in 1902 had selected a dwarf type of wheat plant, the straw of which seemed to have a desirable characteristic of economic value. He had bred plants from this dwarf type through various generations and had always selected dwarf types, but although the selection had been continued for ten years, the dwarf plants never bred true.

In the first year of the investigations at Cambridge it was apparent that the progeny of the dwarf plants was not uniform, and that in general it consisted of plants of different height and of different ear-type. The lax eared plants were distinctly taller than the dense. Ear density was the variable which was studied.

The authors found that dense-eared plants, on self-fertilisation, yield a progeny containing three types—lax, dense and pigmy. Laxed-eared plants continued to breed true. Dense-eared plants were characteristically fluctuant in general development, and in some cases remained stunted and failed to protrude ears. On selfing they yielded three types again. Pigmies are bushy plants, and under ordinary conditions fail even to produce apparent flowering stems.

Subsidiary tests which had been carried out are also discussed.

Inheritance in Wheat, T. Turgidum × T Durum Crosses, with Notes on the Inheritance of Solidness of Straw *F. L. Engledow, M.A., and J. B. Hutchinson, B.A., Cambridge, Journal of Genetics, Vol. 16, No. 1, November* 1925.—The salient features of the actual parent forms are described and a detailed description of the first generation and the second generation progenies is also given, especially with reference to ear and grain characters, and to endosperm texture. Some wheats have almost entirely solid stems, others are solid only in the top internodes, and there are wheats which have entirely hollow stems. It is considered that elasticity of straw in cereals is probably an important factor in lodging, solid-strawed wheats generally having greater elasticity. It was considered desirable to determine the mode of transmission of solidness of straw in connection with the breeding of non-lodging forms. Four crosses involving five parent forms are described, and illustrations are given of the degree of solidness in the parent stems at two selected points.

It is concluded that solidness of straw is inherited on a one factor basis and that it is not linked to any other character of the wheat plant.

The Effect of Length of Day upon the Growth and Reproduction of some Economic Plants. *M. A. H. Tincker, M.A., M.Sc., Annals of Botany, Vol. XXXIX., No.* 156, 1925.—The experiments described were undertaken with the object of discovering how far it might be possible to control and to modify the vegetative growth of various plants hy altering the period of daily illumination. Particular attention was paid to the behaviour of different strains of herbage plants, whose hereditary characteristics were also under investigation. In investigating the behaviour of the plants, they were grown in boxes or pots placed on trucks and were rolled in and out of a large three-sectioned hut, so that the different series received 12, 9 and 6 hours daylight. Control plants were grown in similar pots and received the full natural daylight of the season. When plants of soya beans, chrysanthemums and runner beans were exposed to shortened days, flowering was accelerated. Growth was also modified and controlled Three varieties of red clover and several species of grasses and radish were exposed to short periods of illumination, and in these cases flowering was retarded. Foxglove gave results of an intermediate type; although growth of the flowering axis was reduced by very short days and by very long days, the time of flowering was not materially altered. It is considered that the length of day factor consists of a number of units all of which affect the plant's activities, and that length of day brings about fine adjustments in the amount of water passing through the tissues and operates by affecting the sugar-starch reaction.

Among the interesting results obtained from the grasses was the fact that the majority of late strains showed a comparatively higher and possibly narrower range of length of day in which they can flower, whereas the earlier types can produce flowers in a lower range of length of day.

It was found that late indigenous cocksfoot did not flower with usual vigour under days of 12 hours, whereas French hay cocksfoot did.

Physiological Pre-Determination Experiments with certain Economic Crops. The Relation between Rate of Germination and Subsequent Growth. *M. A. H. Tincker, M.A. (Cantab), M.Sc. (Lond.), Annals of Applied Biology, Vol. XII., No.* 4, *November* 1925.—The experiments were carried out by the author in order to study the effects of different treatments of seeds upon the rate of germination and growth; the effect of the state of maturity of the seed, husk removal and drying on the germination of oats (two varieties); the effect of drying seed on the subsequent growth of oats; the effect of husk removal on the growth of the seedlings of one variety of oats; the effect of soaking the seed on the germination and subsequent growth of oats and wheat; the effect of soaking the seed on the germination and growth of various species of grasses; the effect of soaking the seed on the germination and growth of some economic leguminoseæ.

The importance of the condition of the seed at the time of sowing is emphasised because the condition of the seed affects not only the rate of germination, but also influences the subsequent growth of the seedling. Careful removal of the husk favoured an increased rate of germination and more rapid first leaf development. This effect could be traced throughout a long period in the life of the plant. Soaking the seed of oats in water also increased the rate of germination and subsequent growth.

When the seed of several species of grasses (cocksfoot, timothy, tall and meadow fescues and ryegrass) had been soaked, it accelerated germination and stimulated growth so as to give high yields of herbage. The results with leguminous seeds varied as to the species. Broad beans soaked in water grew more rapidly; little effect was observed in peas, and an adverse effect was produced by such treatment on dwarf beans and crimson clover. It appears that a definite correlation exists between the vigour of germination and the rate of subsequent growth in the case of oats.

SOILS.

Colloids and their Importance in the Soil. *H. J. Page, Agricultural Progress, III,* 15 (1926).—A popular account of the subject is given and most of the paper consists of a simple description of the nature and principal properties of colloids, such as affinity for water, capacity for existing as sols or gels and power of absorption.

The two chief colloids in soils are clay and humus, and the importance of

the above-mentioned properties is discussed in relation to questions of texture, water-holding power, baking, cracking and puddling of soils and in the action of manures. It is pointed out that when a clay soil is wet it tends to go into the sol condition (becomes deflocculated), and that mechanical action of implements when the soil is wet tends to accentuate this condition by breaking up the compound particles, making the soil sticky and plastic. Fertilisers which leave an alkaline residue in the soil, such as nitrate of soda, favour deflocculation, whereas lime and the action of frost bring about flocculation and lead to a crumbly condition.

The property which soils possess of retaining fertilisers in such a way that they are not readily washed out is largely due to the soil colloids.

The Effect of Boron on Plant Growth. *W. E. Brenchley, Agricultural Progress, III*, 104 (1926).—A preliminary note to the effect that certain plants, particularly many members of the leguminosæ, appear to require the presence of minute traces of boron to complete their growth satisfactorily. Ordinary soils are supposed to contain sufficient for normal growth.

Losses of Phosphoric Acid by Leaching from Upland Soils in N. Wales. *G. W. Robinson and J. O. Jones, Agricultural Progress, III*, 39 (1926).—In this preliminary communication some of the results of phosphate experiments commenced in 1914 are given. Most of the figures relate to an acid soil derived from Silurian shales situated at an altitude of over 1000 feet and with an average annual rainfall of 45 inches. Analyses show that phosphoric acid applied in the form of slag gradually disappears from the upper layers of this soil, and eight years after application the effect of the dressing (as revealed by analysis) had practically disappeared.

It is suggested that it may be necessary in certain soils to follow up the first heavy dressing of phosphates by smaller dressings, say 4 cwt. of basic slag every four years.

The Official Method for the Mechanical Analysis of Soils adopted by the Agricultural Education Association in 1925. *Agricultural Progress, III*, 106 (1926).—The new official British method which replaces the sedimentation method of 1906 differs from the old method principally in the following points:—

(*a*) The analysis is carried out on material passing a 1 mm. sieve instead of a 3 mm. sieve.

(*b*) The sample to be analysed undergoes a preliminary treatment with hydrogen peroxide to destroy organic matter and thus allow more complete dispersion of the soil.

(*c*) The finer fractions are estimated by a pipette method which depends on the depth-concentration relationship in a settling suspension. This considerably shortens the time required to carry out an analysis compared with the former method.

A memorandum describing the method can be obtained from the Secretary of the Agricultural Education Association, University College, Reading. (Price 3d., post free.)

Proposals for a Soil Survey of Wales. *G. W. Robinson, Welsh Journal of Agriculture, II*, 143 (1926).—"The ultimate object is to secure as far as possible the representation of the different types of soil in map form and to secure such a record that it will be possible, by reference to the soil maps and their accompanying memoirs, to ascertain the general character of the soil in any locality in Wales. This should facilitate the giving of advice on manuring and soil treatment, since it will be possible to group together certain areas as similar in soil, surface features and climate. Could such a grouping be obtained, the next step would be the location of permanent field experiments according to the principal types of grouped factors."

In order to enable this project to be carried out, a grant has been made by the Ministry of Agriculture and Fisheries, and mapping is to be carried out on the scale of 6 inches to the mile

The presence of glacial drift in Wales makes it impossible in preparing a soil map to follow closely the geological boundaries. The principal properties to be considered are the texture of the soil and the relationship to the underlying strata of subsoil and parent material.

What happens to the Lime when Soil is Limed? *D. J. Hissink, Transactions of the Second Commission of the International Society of Soil Science, A.* 174 (1926).—Lime applied to soil is—

(*a*) taken up by the crop ;
(*b*) washed out by rainwater ;
(*c*) absorbed by the clay-humus substance ;
(*d*) left behind in the soil in the form of carbonate of lime.

It is supposed that the object in liming is to keep up the supply of lime in the clay-humus substance.

If the amount of lime actually held by the clay-humus substance in a soil is low in relation to that soil's total capacity for absorbing lime, the soil is said to have a low degree of saturation. When lime is applied to an unsaturated soil it is quickly taken up by the clay-humus substance, but when applied to a more saturated soil, much less is taken up, the bulk of the lime remaining in the soil as carbonate of lime.

Experiments show that the lime absorption is highest when the lime applied is fine grained and thoroughly mixed with the soil. In one case coarse-grained lime was applied to a heavy clay soil deficient in lime, and was not thoroughly incorporated with the soil. The result was that very little lime was taken up, most of it remaining in lumps, and little benefit was obtained.

ANIMAL NUTRITION.

The Value of Calcium Phosphate as a Supplement to the Ration of Dairy Cows. *S. B. Lindsey and J. G. Archibald, Jour. Agri. Res., Vol. XXXI, No.* 8, 1925.—The object of this experiment was to test the effect on health, composition of the milk, reproductive functions, &c, of adding supplemental inorganic salts of lime to the rations of dairy cows. The whole station herd, consisting at the beginning of the experiment of 20 head of Holsteins and Jerseys and comprising milk cows, yearling heifers and eight-months-old heifers, has been fed for two and a half years on a ration decidedly low in calcium, too low from the standpoint of our present knowledge for the needs of the animals. One half of the herd had the deficiency made good theoretically by supplementing the ration with calcium phosphate in the form of steamed bone meal.

The following are some of the facts revealed by the investigation :—

(1) Irrespective of the group to which they belong, the experimental procedure has had no prolonged ill effects on the general condition of the aged cows, of the young Holstein cows or of the heifers, but has apparently seriously disturbed the metabolism of the young Jersey cows. Two of these Jerseys had received the mineral supplement, and all had an unthrifty appearance, thin flesh and rough hard coats.

(2) There was no significant difference in the rate of growth of the two groups

(3) Milk production has not been significantly affected either by the low calcium ration or by the mineral supplement except in the case of the young Jersey cows. They did not milk as freely or as persistently as it was expected they would. The mineral supplement has had no effect in increasing the milk yield.

(4) With the possible exception of calcium, the composition of the milk has not been appreciably affected. The percentage of calcium was slightly higher in the mineral group.

(5) The reproductive function has been more seriously disturbed than any other, considerable difficulty being experienced in getting the cows with calf. This difficulty has increased as the experiment has progressed, but has been equally divided between the two groups.

(6) Each group has produced about the same proportion of healthy calves. The non-mineral group has had much the higher proportion of delicate calves, but this is due in part to breed characteristics.

Tankage and Buttermilk as Protein Supplements for Growing Pigs. *E. F. Ferrin and M. A. M'Carty, Agri. Expt. Stn. Univ. of Minnesota Bull.* 221, 1925.—Skim milk or buttermilk and tankage are amongst the most valuable of high protein feeds. Semi-solid buttermilk and dried buttermilk, both of which can be stored for future use, have appeared on the market and an ex-

periment was planned to test the relative value of these feeds. Four groups of pigs were used in the experiment, all receiving the same basal ration. Group 1 had in addition tankage, group 2 dried buttermilk, group 3 semi-solid butter milk and group 4 creamery buttermilk. The pigs were allowed access to rape pasture, while a mineral mixture was fed regularly. In an average of two separate trials both identically carried out, it was found that the group receiving tankage as supplement put on 1.12 lbs. per pig per day, the other three groups each putting on 1.21 lbs. From an economic point, however, the tankage group were the most successful, costing $5.53 per 100 lbs. gain, the creamery butter-milk group being next, costing $5.75, dried buttermilk and semi solid butter-milk groups costing $6.98 and $8.08 respectively. The saving of time necessary to increase the weight of a growing pig by 100 lbs. was six days, when either kind of buttermilk was fed instead of tankage. Not considering cost, the use of any of the four protein supplements resulted in satisfactory gains.

Rickets and Paralysis in Swine as affected by Nutrition. *Bohstedt, Bethke, Edgington and Robinson, Ohio Agri. Expt. Stn. Monthly Bull., Vol. 9, Nos. 9 and 10, 1924.*—Lameness, unthriftiness, partial paralysis or rickets in pigs is very prevalent especially in winter and early spring, and apparently there is something lacking in winter rations that is usually contained in summer rations, when rickets rarely occurs. The object of this experiment was to determine the factor or combination of factors which causes rickets or partial paralysis in pigs.

Ten groups of eight Poland China pigs were used, and none of the pigs had access to any green growing vegetation or even to soil. They were all fed a basal ration of white corn, flour wheat middlings, linseed meal, blood meal and salt, supplemented with various minerals, proteins, vitamins and combinations of these.

Group 1 received basal ration alone, and the following were the additions to the other nine groups:

Group 2 calcium carbonate; Gr. 3 di sodium phosphate; Gr. 4 precipitated bone flour; Gr. 5 casein; Gr. 6 casein *plus* precipitated bone flour; Gr. 7 cod liver oil (for vitamin A); Gr. 8 cod liver oil *plus* precipitated bone flour; Gr. 9 aerated cod liver oil *plus* precipitated bone flour; Gr. 10 basal ration without blood meal.

The experiment lasted for 160 days, and the average daily gain per pig in the different groups were:—

Gr. 1 0.41 lbs.; Gr. 2 0.33 lbs.; Gr. 3 0.42 lbs.; Gr. 4 0.55 lbs.;
Gr. 5 0.62 lbs.; Gr. 6 0.57 lbs.; Gr. 7 1.08 lbs.; Gr. 8 1.06 lbs.;
Gr. 9 0.95 lbs.; Gr. 10 0.51 lbs.

The feeding of cod liver oil and bone flour or what appears to be the essential vitamins and minerals made for the best results as regards growth, and the food consumption per 100 lbs. gain was much smaller than in the other groups. The addition of vitamins alone furnished a strong growth impulse, but, in the absence of minerals, made for brittle bones that were easily broken. The addition of minerals alone did not prevent paralysis, while improving the protein by adding casein or blood meal, even in combination with minerals, cannot be considered a preventive.

Rearing Calves by the Use of Calf Meal Gruel. *Maynard, Morris and Kraus, Cornell Univ. Agr. Expt. Stn. Bull. 439, June 1925.*—The dairyman who has plenty of skim milk available can rear good calves cheaply, but where skim milk is not available the rearing of calves is a more difficult problem. A method of rearing calves which has received considerable study is the substitution for skim milk, after the first few weeks, of a special grain mixture, generally called a calf meal, which is fed as a gruel. Special attention has been paid at the above station to digestive disturbances such as scouring, &c., which follow the feeding of calf meals, and as a result of many preliminary tests the following mixture has given much better results than any previously tried or reported elsewhere:—250 lbs. yellow corn meal, 250 lbs. red dog flour, 150 lbs. ground oat groats, 150 lbs. linseed oil meal, 100 lbs. ground malted barley, 100 lbs. soluble blood flour, 10 lbs. calcium carbonate, 10 lbs. precipitated bone meal and 10 lbs. salt. All the ingredients have been selected to make this mixture very low in fibre. The gruel was made by mixing the calf meal with water at about 100° F. in the proportion of 1 to 5 of weight. In changing from milk to gruel

the first addition of gruel was ½ lb per feeding, and the amount was gradually increased and the quantity of milk decreased till the change was complete.

A series of three trials, involving 23 heifer calves, with the above calf meal are recorded. Thirteen pure-bred Holstein calves made an average daily gain of 1.67 lbs, reaching an average weight at 6 months of 394 lbs, 7 grade Holsteins made an average daily gain of 1.44 lbs, and 3 pure-bred Shorthorns made an average daily gain of 1.46 lbs. These gains are comparable to the results obtained with skim milk. The use of the calf meal is a much cheaper method than the use of whole milk, and the growth and development obtained by this method exceed those obtained where whole milk has been fed during the first two or three months and then changed to hay and grain alone.

Feeding Trials with Fattening Bullocks. *J. P. Drew, Department of Lands and Agriculture, Ireland, Vol. XXV, No.* 3, 1926.—An experiment was carried out at the Albert College to test the effect on the rate of growth of two year old bullocks by replacing a certain proportion of roots and concentrates in the ration of silage. Four groups of eight shorthorn bullocks were fed for a preliminary period on both roots and silage until they became accustomed to the feed, when the rations then became:—

	Roots	*Silage*	*Concentrates*	*Hay*
Gr. I	40	—	5	10
Gr. II	30	10	4	10
Gr. III	20	20	3	10
Gr. IV	40	35	—	—

In making the replacements in Groups II and III it was assumed that 5 lbs. of silage as a food unit according to the Scandinavian system of comparing feeding stuffs and the silage is made to replace an equal number of food units of roots and concentrates.

The experiment lasted for 84 days, when it was found that in Group I the average increase per bullock was 2.0 lbs. per day, in Group II 1.75 lbs., in Group III 1.53 lbs. and in Group IV 0.76 lbs. per day. Thus it would seem that the replacement of roots by silage had a depressing effect on growth, but it was noted that the bullocks in Group II made relatively a much smaller increase for the first month than Group I, their increase being even lower for this period than for Group III. After this first month, however, the daily increase for Group II was higher than for any of the other groups, viz. — Group I 1.65 lbs. per day, Group II 1.73 lbs., Group III 1.31 lbs., Group IV 0.69 lbs. per day. No reason can be adduced to account for the small increase of Group II during the first month but it can hardly be associated with the silage seeing that Group III, which was eating double the quantity, made a greater gain during this period.

It may be safely stated that silage made from beans, vetches and oats may replace concentrated foods for winter fattening of cattle on the basis that the food unit of silage is 5 lbs., but there seems to be a limit to the amount of silage that may profitably be fed to a fattening bullock.

Whey Research Factory at Haslington. Pig Feeding Experiments with Lactose Residues. *J. Golding and W. B. Morris, J. Min. Agri. Vol.* 32, *No.* 10, 1926.—Experiments have recently been conducted at Reading to test the value as a foodstuff for pigs of a "lactose paste" and a "lactose feed," two products from whey which have been engaging the activities of the Whey Research Factory at Haslington. The lactose paste is formed by the concentration of the whey in vacuo, when the easily crystallisable portion of the sugar is removed and the residue is concentrated to a paste. This residue is also used to form the lactose feed by mixing it with brewers' and distillers' grains, after which it is dried. There were considerable differences in the analyses of the paste, especially in the moisture content. The analysis of the lactose feed was:—Moisture 15.30 per cent., Fat 4.72 per cent., Albuminoids 69.93 per cent., Carbohydrates 43.75 per cent., Fibre 6.81 per cent., and Ash 9.94 per cent. This analysis corresponded fairly closely with the analysis of bean meal, and in the experiments undertaken the paste and feed were tested against bean meal both for pork and for bacon production, not more than 12 per cent. of either the paste or the feed being used in the ration. In each of four experiments it was found that the pigs receiving the paste and the feed made slightly

better gains with a smaller food consumption than the pigs getting bean meal, although in one experiment only could the gains be considered satisfactory. It would appear that these whey products possess in common with other by-products from the dairy some factor or factors which beneficially influence the growth and general well-being of pigs. The condition of the pork and bacon was also improved, and at the prices at which these products were sold (£10-£12 per ton) a good return might be expected if used to the extent of 10 to 12 per cent. of the ration.

ANIMAL BREEDING.

Judging of Dairy Cattle and some of its Problems. *John W. Gowan, Journal of Heredity*, 17, 13 26, 1926.—The main purport of this experiment is centred round an attempt to find out if any combination of body measurements can be evolved which will establish a significant correlation between conformation and milk yield. The author also attempts to find if conformation is in any way related to the butter-fat percentage content of milk Having considered how far conformation is indicative of milk yield and of butter-fat content, the author endeavours to show the relative efficiency of various methods of predicting productivity in dairy cattle such as seven-day lactation records, performance of female ancestors, skill of experienced judges and definite measurements of body conformation. Holstein-Friesians were used in this experiment.

As milk yield is affected by age, all correlations between body measurements and total milk yield were made on an age-corrected basis The various measurements were then compared with the performance records in order to find their relative efficiency in predicting the probable milk yield. All cows used in the experiment were making the Registry of Merit, so that the relation of productivity and heredity could be measured both as regards butter-fat and total milk yield. The same cows were also subjected to judging tests in order to indicate how far the eye of the skilled and experienced judge could be relied on to predict the probable milk yield. Seven-day lactation records were also taken and compared with the performance records. The writer then proceeds to consider the relative efficiency of these afore-mentioned modes of procedure in predicting productivity in dairy cows.

No correlation is found to exist between butter-fat content and any of the parts of conformation. The best indication of butter fat percentage during a whole lactation period is derived from the short period test of seven days, but it may also be predicted with a considerable but somewhat less degree of accuracy by studying the butter-fat percentage of records of the female ancestry.

As regards total milk yield over a lactation period, the most accurate indication is obtained from the short period test of seven days, and about an equal degree of efficiency is obtained by studying the performances of the female ancestors. The total correlation co-efficient of conformation to performance is only about two-thirds as accurate as the short period test of seven days. The results of judging by the use of the score card proved to be only half as accurate as the seven-days test as indicative of the probable milk yield.

The author makes no dogmatic assertions regarding any body measurement or combination of body measurements as being of special value in predicting the productivity of a dairy cow, but indicates that the most influential of these body measurements is that of weight closely followed by body length, hip width and body girth. Probably the most important conclusion obtained from these measurements is that length of rump has a relatively low relation to productivity, as judges lay particular stress on the development and length of the rump in the belief that it is the precursor of a lengthy udder, and hence indicative of the animal's aptitude to be a heavy milker.

In view of the correlation between milk yield and body weight, this is, in the author's opinion, a justification for selecting larger cows. It seems that the writer is not justified in making this assertion without taking into account the ratio of the maintenance to productive rations in relation to the body weight.

Segregation in Half-bred Sheep. *Journal of Heredity*, 16, *pp.* 401-408, 1925.—A general preliminary account is given of observations which were made on the first and second generations of the Border Leicester-Cheviot cross with a view to determining the amount of segregation into parental types

which might occur. The sheep were examined according to fleece, body and head characters. A considerable range of variation in fleece characters was found in the first cross ewes and when these were mated with first cross rams; their offspring (the second generation of the cross) showed a greater range of variation and distinct evidences of segregation, it being possible to classify the animals according to type judged by body and head, as well as fleece, characters The observations are discussed, and it is shown that the behaviour of this cross in subsequent breeding is quite in accordance with Mendelian theory and expectation.

DAIRYING.

Feeding Experiments for Milk Production. *W. H. Hicks, Canada Expt. Farms, Agassiz (B C), Farm Rpt.*, p 9 (1925).—An allowance of 60 lbs. of mangolds per cow per day was compared with one of 6 lbs of dried beet pulp and ¾ lb of molasses The basal ration throughout contained a very liberal amount of silage The average daily yield of milk was 26 66 lbs on the mangold ration and 28 31 lbs on the beet pulp ration.

In a comparison of maize silage and sunflower silage the basal ration consisted of 12 lbs concentrates, 20 lbs pulped mangolds and 5 lbs clover hay. In addition the cows were allowed to consume all the silage they wanted, and their consumption averaged 60 lbs per head daily during the sunflower silage periods and 67 lbs during the maize silage periods, while the average daily milk production was 33 60 lbs with the maize silage and 31 52 lbs with the sunflower silage.

Turnips, Corn Ensilage and Sunflower Ensilage for Dairy Cattle *W W Baird, Canada Expt Farms, Nappan (N S), Farm Rpt*, p 9 (1925)—In a trial of 63 days duration 3 groups of 3 cows each were used in comparing turnips with maize and sunflower silages The average daily milk production per cow was 19 19 lbs on turnips, 17 04 lbs on maize silage and 17·81 lbs on sunflower silage, while the most economical production was obtained with the turnips

Silage Vs. Oat and Pea Hay Vs. Roots. *J A Ste. Marie, Canada Expt. Farms, St Anne de la Pocatière (Que), Sta Rpt, p* 8 (1925)—Maize silage and oat and pea hay were compared in a 63 day trial with 12 cows while in a similar trial maize silage was compared with roots. In the first trial the average daily milk production per cow was 19 1 lbs on silage and 18 6 lbs on oat and pea hay, while in the second trial it was 15 8 lbs on silage and 16·4 lbs. on roots

The Comparative Value of Peanut Meal, Cottonseed Meal and Soybean Meal as Sources of Protein for Milk Production. *C W. Holdaway, W B. Ellett and W G Harris, Virginia Sta Tech Bul* 28 (1925)—This is a report of feeding and digestion trials in which the comparative utilisation of the proteins from earthnut, cottonseed and soybean meals was studied The basal ration consisted of maize silage, maize meal and maize starch It was found that for the production of one pound of milk protein the amounts of absorbed protein required were 2 61 lbs from earthnut meal, 3 07 lbs from cottonseed meal, and 2 76 lbs from soybean meal

The Feeding Value and Utilisation of Rape Seed and Hemp Seed Cakes. *N Hansson, Meddel Centralanst. Forsoksv Jordbruksomradet, No* 274 (1924)—Rape seed cake was slightly better, pound for pound, than a mixture of equal parts of earthnut cake and ground oats, while hemp seed cake was found to be of slightly lower value for milk production than was rape seed cake.

Bacterial Count of Whole Milk and that of the Cream and Skim Milk separated from it *C S. Leete, Journal of Agricultural Research*—Centrifugal separation with a clean separator does not result in the cream having a higher bacterial count than the whole milk from which the cream is obtained. Gravity separated cream, on the other hand, will give a much higher count than the whole milk from which it comes

Milking Machines and Mastitis. *Steenstroem Vet. Coll., Stockholm.*—Steenstroem finds that milking machines play no part in the transmission of

mastitis in a dairy herd. When the machine used on cows with malignant streptococcus inflammation is immediately afterwards put on to cows with healthy udders, no infection follows, even when the teat cups are filled with highly infected milk before affixing. In reality, infection by milk plays no part at all, because streptococci enter the udder by way of the alimentary canal.

Milk-borne infection of Typhoid.—An outbreak at Lincoln Memorial University, Harrogate, Tennessee, U.S.A., between January and May of 1924, involving at least 100 cases and 8 deaths, was traced to unpasteurised milk obtained from a farm where sanitary conditions were such that it was quite certain that the milk became contaminated from sewage polluted water used in washing the milk cans.—*Obstr. Bacteriolog.*, *Oct.* 1925.

The value of Boron Compounds in preserving Butter. *New Zealand J. Agr.* 31, 197-8 (1925).—The addition of "boron-compound" in amounts ranging from 0·08 per cent. to 0·99 per cent. has little effect in sustaining the keeping quality of butter, either in cold storage or afterwards at room temperatures. In seven experiments with butter from different sources, the average was only slightly in favour of the preservatized butter.

Effect of Various Factors on the Creamery Ability of Market Milk. *U.S. Dept. Agr. Bulletin*, 1344.—Market milk which has been pasteurised frequently shows a diminished cream volume when compared with the same milk in the raw condition. To determine what operations in the processing of the milk exerted an unfavourable influence on the cream line, an extended study has been made by the Bureau of Dairying of the U.S. Department of Agriculture and is reported in this important publication.

(1.) Pumping milk at temperatures between 120° and 60° F. diminishes the cream line slightly. Pumping milk below 60° F. or between 120° F. and 145° F. is practically without effect on the cream line.

(2.) Holding the milk or agitating it for 15 minutes or more at temperatures between 60° and 110° F. has a detrimental effect on the cream line.

(3.) Clarifying milk above 80° F. decreases the cream volume, but filtering milk hot has no effect on the cream line.

(4.) Milk pasteurised to 143° F. for 30 minutes shows a normal cream line; between 145 and 146° F. there is an average reduction of 8 per cent. in the cream line; at 148° F. the average reduction in the cream line is 31 per cent.

(5.) A moderate amount of agitation during the holding period has no appreciable effect on the cream volume.

(6.) Milk cooled in tank or vat pasteurisers from 145° F. to 50° F. shows a poor cream volume, but cooling in the vat or tank to 120° F. and then cooling quickly over a separate cooler to 50° F. gives a good cream volume.

(7.) Cooling milk to a low temperature after pasteurisation is necessary to obtain a good cream volume. Pasteurised milk cooled to below 45° F. shows a much better cream volume than that cooled to 50° F. or above.

(8.) Low storage temperatures for the bottled milk is an important factor in the cream volume. Milk stored at 38 to 48° F. shows a better cream layer than milk stored at 50° F.

INSECTS AND PESTS.

Colorado Beetle Infestation in France—Recent Reports. *J. Feytand in Rev. Zool. Agr. et App.*, *Vol.* 24, 1925.—The recent appearance of the Colorado beetle in France and its establishment over an area of some size, raised several questions which only time could solve. The most important of these was whether man, assisted by the latest methods of pest control, could speedily free the country entirely from the alien pest. Sufficient time has elapsed to show that this desirable object is not likely to be accomplished rapidly, if at all. The author contrasts the area in France overrun by the Colorado beetle in 1925 with that occupied a year previously. During the course of that year the beetle has spread to new areas, and the best that can be said is that the 1925 area is not larger than that of 1924, for while the pest has spread southward it has contracted its borders on the north and west. Fortunately, the great potato-growing districts of the country are still free from infection, but so long as a real control over the beetle is lacking, an extension of its presence and ravages

may occur almost at any time The difficulty encountered in France in reducing the infested area shows how necessary it is to prevent the settlement of the beetle in Great Britain, and how stringent should be the examination of potatoes or vegetation likely to harbour it

A Good Word for the Mole *H Sachtleben in Arb Biol. Reichanst Land u Forstw*, *Vol* 14, 1925 —The author has examined the stomach contents of 140 moles and finds that their food is largely composed of the underground larvæ of insects A very large proportion of the food consisted of wireworms and the grubs of cockchafers, both serious pests of crops, and in view of this he is of opinion that, unless they are present in excessive numbers, moles should be encouraged on agricultural land

Frit Fly and Smut *I A Novik*, *Abs in La Défense des Plantes, Leningrad*, *Vol* 2, 1925 —Observations on the biology of frit-fly under both natural and artificial conditions have been carried out in the department of the Ukraine by L A Novik He considers that there is a direct relation between the amount of smut and the abundance of frit fly, and suggests the possibility that the fly carries the spores of the fungus and thus aids its dissemination He is therefore of opinion that, as well as early spring sowing, the infection of the seed from smut should be guarded against as a step towards counteracting attack by frit fly.

Rate of Egg laying in the Honey Bee. *W J Nolan, in Depart Bull No* 1349 *of U S Dept Agr*, *Sept* 1925 —In this important paper, discussing the relation of the brood cycle of the honey bee to honey gathering and other conditions within the hive, the author states the results of his counts of sealed brood as indicating the rate of egg laying Methods of investigation have advanced greatly since 1740, when the great French scientist, Réaumur, regarded the daily average at the height of the egg laying season to be 200 eggs a day Yet, till Berlepsch actually counted the eggs laid by an isolated queen in 1856, it was not credited that Réaumur's number far underestimated the truth Berlepsch counted 3021 eggs, laid in the single comb to which the queen was confined for 24 hours Subsequent studies show that this must have been an exceptionally prolific queen, for it is seldom since that even a 2000 daily count has been attained

Mr Nolan's counts were made upon sealed brood, so that they clearly do not indicate actual egg laying, since some eggs never hatch and others which hatch do not survive The numbers, however, may be taken to show the brood-rearing quality of the egg laying, a matter of more importance to the bee keeper than an academic study of eggs, good, bad and indifferent His highest daily average during a twelve day period, from 15 colonies under observation, was 1587 in 1922 In the previous year the same queen had averaged 1468 In 1921 the maximum in the 15 colonies was 1513 a day There was, as might well be supposed, a wide variation in the accomplishment of different queens Thus while in 1921 five colonies showed average daily rates between 1250 and 1400, six fell between 1000 and 1250 In 1921 the maximum daily average of each of the two year old (1919) queens was below 1000 "Although it cannot be concluded from this investigation that the use of old queens is always disastrous, the records show that their use is accompanied with risk"

The author agrees with Dufour that there is no warrant for supposing that egg laying rates exceeding 3000 per day have been attained in the colonies under their observation Further, since the daily average over a season falls much short of the average during the days of the maximum egg laying period, he warns readers against accepting the remarkably high rates of egg-laying over short periods, so often published in bee-keeping literature, as giving any sure guide to the total seasonal activity.

The Destruction of Ox-Warbles. *H W. Thompson, Welsh Jour Agr*, 1925, p 200 —During the spring of 1924 a fairly extensive test was made to discover the value of a dressing of lime and tobacco powder in the treatment of warbles A mixture of 1½ lbs fresh lime and 4 lbs tobacco was allowed to stand in 1 gall water for 24 hours Having been then strained it was applied to infected areas with a sponge, in such a way that a little of the fluid penetrated the breathing hole of each of the warbles. After two or three days a fresh

application was made with freshly prepared fluid, and thereafter it was found that 90 per cent. of the warbles had been killed. The experiment was completed by a third application of the mixture after a period of three weeks, and this resulted in the total extermination of the warbles present As the experiments were carried out with success upon six herds of cattle, they indicate that here is a method, easy of preparation and application, which, if applied to cattle between March and May, should affect a very considerable reduction in the amount of damage caused by ox-warbles to hides.

The Food of Earwigs *M. T. Goe in Entomol News, Philadelphia*, 1925, *p.* 234 - In view of the general notion that earwigs are vegetarian in their diet, the results of these experiments are of interest The author studied earwigs closely for eight months, and during that time every effort to entice them to feed upon vegetable matter failed, although leaves and flowers of many different kinds were offered them. On the other hand, carnivorous food such as raw meat, dead slugs, flies and grasshoppers and living aphids were greedily devoured Since it has been alleged that earwigs damage carpets and clothing, they were offered cloths of various kinds, but even when other food was kept from them, they altogether refrained from a textile diet The author notes a curious habit in his observation that the eggs are hatched with the aid of the female insect They are arranged in a nest in the soil, and during the incubation period of 15 to 18 days the female remains in close attendance, which is kept up in the soil for several days after the young have emerged

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FERTILISERS and FEEDING STUFFS in December 1925, and January and February 1926.

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	December.			January.			February.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
FAT STOCK:—									
CATTLE—	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.
Aberdeen-Angus ...	71 1	63 8	46 7	67 10	61 4	44 5	65 1	59 2	43 2
Cross-bred (Shorthorn)	65 8	58 2	42 8	63 1	56 3	40 2	61 1	54 3	39 2
Galloway	64 3	57 8	..	60 3	54 6	.	59 6	55 2	..
Ayrshire	62 5	49 2	35 2	60 9	47 6	34 6	59 0	49 6	35 0
Blue Grey	64 0		...	59 3	...		60 0		. .
Highland	65 0	60 9	...	...	56 0	...	...	..	...
VEAL CALVES	per lb. d. 18½	per lb. d. 13½	per lb. d. 9½	per lb. d. 16¾	per lb. d. 13	per lb. d. 7¾	per lb. d. 16¾	per lb. d. 13	per lb. d. 7¾
SHEEP—	under 60 lb per lb. d.	60 lb. and upw'ds per lb. d.	Ewes per lb d	under 60 lb. per lb. d.	60 lb. and upw'ds per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot	15	13¼	10¾	15½	13½	11	15¾	13¾	11¼
Half-bred	15	13½	9¾	15¼	13¾	9½	15¼	14	10¼
Blackface	14¾	13	10	15¼	13	10	15½	13½	10¾
Greyface	15	13¼	9	15¼	13½	8½	15¾	14¼	9¾
Down Cross	15¼	13¾	...	15¼	13¾	...	15½	14	...
PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	14 6	13 5	...	14 6	13 6	9 6	14 7	13 6	.
Porkers	14 9	13 10	..	15 0	14 1	9 6	15 1	14 0	...

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND—*continued.*

Description.	December.			January.			February.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
STORE STOCK:—									
STORE CATTLE—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head	Per head	Per head
Aberdeen-Angus:	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	18 15	15 18	13 3	18 0	14 17	12 15	18 11	15 2	13 8
Two-year-olds ..	24 12	20 7		24 1	20 5	..	24 7	20 11	19 15
Cross-bred (Shorthorn):									
Yearlings	17 8	14 14	12 11	16 18	14 12	11 18	16 14	14 1	12 1
Two-year-olds	22 13	18 17	15 18	22 13	18 3	.	22 14	18 11	16 18
Galloway:									
Yearlings .. .	16 0	14 0	.	15 10	12 0	...	16 0	...	
Ayrshire:									
Yearlings		.	.	..	.	..	16 10	.	
Blue Grey:									
Two-year-olds	...	..	.	26 0	..	..	.	.	.
Highland:									
Yearlings ..	11 0	10 4	7 10	.	...		...	...	.
Two-year-olds ..	17 0	13 9	..				...		...
Three-year-olds ..	...		...	19 0	16 0				..
DAIRY COWS—									
Ayrshire:									
In Milk .	33 7	25 5	13 16	32 19	23 11	13 6	32 3	23 6	13 6
Calvers . ..	31 15	24 6	15 0	30 13	24 5	15 4	32 17	24 6	15 1
Shorthorn Cross:									
In Milk	39 4	30 18	20 11	38 2	29 11	20 0	37 1	28 6	18 8
Calvers	37 16	28 9	18 11	35 14	27 7	17 18	34 0	25 19	16 19
STORE SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	.	...	..	.	35 0		45 5	34 11	..
Half-bred Hoggs ...	.	51 0	48 6	66 1	48 9		68 6	57 5	51 5
Blackface Hoggs ...	...	..	...	...	...	27 9	...	31 2	24 2
Greyface Hoggs ..	..	...	..	52 11	46 0	..	53 5	42 4	35 7
Down Cross Hoggs	...	53 7	...	52 0	...	...	64 3	53 3	.
STORE PIGS—									
(6 to 10 weeks old)	45 3	29 10	...	47 7	31 7	...	53 6	37 4	..

Average Prices of Dead Meat at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Quality.	December.			January.			February.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
Beef :—										
Home-fed—										
Bullock or Heifer ...	1	9⅞	9⅝	11¾	9⅝	10	11⅞	9¼	9⅜	11¼
	2	9⅜	8¾	10¼	9¼	9½	10⅛	9	8⅝	10
Bull	1	8¼	7⅜	8⅛	8	7½	7½	7½	7¼	7⅝
	2	7¾	7	7⅜	7½	...	6⅛	7	6½	6
Cow	1	7	6⅜	7¼	7	6	7⅛	6¾	6	7
	2	6¼	6	5¾	6	...	5¾	6	5½	6
Irish—										
Bullock or Heifer ...	1	...	...	9¾	...	...	9½	...	...	9⅝
	2	..	...	8	...	...	7⅝	...	..	8⅛
Bull	1	..	...	7⅛	...	...	6⅝	..	...	6⅝
	2	...	...	6⅝	...	...	5⅝	...	...	5⅝
United States & Canadian—										
Killed at Glasgow ...	1	...	...	9¾	...	...	9½	..	.	9¾
	2	...	...	7⅝	...	...	7⅜	...	...	7⅞
Argentine Frozen—										
Hind Quarters ...	1	6½	5¾	...	...	5⅞	...	...	5½	...
	2	...	5½	...	...	5½	...	.	...	...
Fore ,, ...	1	5	4⅞	...	...	4⅞	...	...	4½	..
	2	...	4½	...	...	4½	...	..	...	...
Argentine Chilled—										
Hind Quarters ...	1	7½	7	7¼	6⅜	6⅜	6½	6	6¼	6¼
	2	6½	...	6¾	...	6¼	6	...	6	5¾
Fore ,, ...	1	5⅛	5⅛	5	4⅜	4½	4⅜	4	4⅛	4
	2	4½	4⅞	4⅝	...	4¼	4	...	3¾	3⅝
New Zealand Frozen—										
Hind Quarters ...	1	..	...	5½	...	...	5½	...	...	5½
Fore ,, ...	1	...	...	4½	...	...	4⅜	...	...	3⅞
Mutton :—										
Hoggs, Blackface ...	under 60 lb.	12⅝	11¼	11¾	12	11⅜	12⅝	12	11⅞	12½
	60 lb. & over	11⅝	10¼	11	11	10¾	11⅝	11	9½	11½
,, Cross	under 60 lb.	12⅝	11¼	11¾	12	11⅜	12⅜	12	11⅞	12⅛
	60 lb. & over	11⅝	10⅜	11	11	10¾	11⅝	11	9½	11¼
Ewes, Cheviot	1	9	7½	8⅛	9	6¾	8	9	8⅛	9
	2	8	...	7¾	8	...	7½	8	...	8¼
,, Blackface ..	1	9	7½	8	9	6¾	8	9	8⅛	9
	2	8	...	6⅞	8	...	6½	8	...	8
,, Cross	1	7	6½	7¼	7	6⅜	7¼	7	7⅞	8¼
	2	6	...	6¼	6	...	6¼	6	...	7¾
Argentine Frozen ...	1	...	...	6¾	..	...	6¾	...	...	6⅞
	2	...	...	5½	...	...	5½	...	...	5⅞
Australian ,, ...	1	...	6⅞	...	...	6	...	...	6	...
	2	...	6½	...	...	5½	...	..	...	...
New Zealand ,, ...	1	...	...	7	...	...	...	...	...	...
Lamb :—										
Home-fed	1	...	11¼	11¾	...	...	12	...	...	12
	2	...	10¾	11⅛	...	...	11½	...	...	11½
New Zealand Frozen ...	1	...	10½	10¼	...	9⅝	10	...	10	10
	2	...	9½	...	...	...	..	...	...	...

Average Prices of Provisions at Glasgow.

(Compiled from Reports received from the Board's Market Reporter.)

Description.	Quality.	December. s. d.	January. s. d.	February. s. d.
Butter:				
Irish Creamery per cwt.	1	191 6	168 0	...
Argentine .. . „	1	...	162 8	166 0
„ (Unsalted) „	1	177 0	165 4	174 0
Australian ... ... „	1	182 0	173 3	177 9
Danish ... ... „	1	200 2	183 3	197 9
„ (Unsalted) ... „	1	206 0	188 3	203 6
Friesland (Unsalted)... „	1	213 0	191 6	213 6
New Zealand ... ... „	1	190 8	181 9	183 6
„ (Unsalted) „	1	190 0	187 8	189 0
Swedish .. ... „	1	190 5	172 6	187 3
Cheese:				
Cheddar ... ... „	1	128 5	130 9	131 9
	2	120 5	122 6	120 0
Cheddar Loaf ... „	1	154 0	152 6	148 3
Dunlop... ... ... „	1	121 7	120 0	117 9
	2	114 7	110 0	110 0
Canadian ... ... „	1	117 2	113 9	114 0
New Zealand (Coloured) „	1	120 0	110 6	111 3
„ (White) „	1	...	109 8	107 9
Bacon:				
Ayrshire (Rolled) ... „	1	163 0	164 3	161 6
Irish (Green) ... ... „	1	154 10	156 9	157 0
„ (Dried or Smoked) „	1	164 10	166 6	167 0
„ (Long Clear) ... „	1	166 0	167 6	160 6
Wiltshire (Green) ... „	1	154 0	155 0	157 0
„ (Dried or Smoked) „	1	164 5	165 0	167 0
American, Long Clear Middles (Green) „	1	122 0	120 0	118 6
„ Short Clear Backs „	1	123 0	120 0	118 6
„ Sides ... ... „	1	119 0	114 0	107 3
„ Cumberland Cut „	1	...	112 8	107 6
Canadian, Sides ... „	1	129 0	122 6	118 3
Danish, Sides ... ... „	1	141 10	134 9	128 0

Description.	Quality.	December. s. d.	January. s. d.	February. s. d.
Hams:				
Irish (Smoked) per cwt.	1	196 0	212 0	197 0
	2	184 0	192 6	180 9
American, Long Cut (Green) ... ... „	1	129 10	119 9	119 0
American, Short Cut „	1	126 5	125 3	120 0
Eggs.				
Country ... per doz.	1	3 6	3 1	2 5
	2	3 4	2 11	2 3
Irish ... ... per 120	1	32 10	25 0	21 8
	2	31 0	23 11	20 3
„ (Stored)... „	1	17 7	17 2	15 3
	2	17 1	16 10	14 6
„ (Pickled) „	1	17 2	16 0	14 0
„ (Duck) ... „	1	24 8	23 0	21 8
	2	21 0	...	18 6
American ... „	1	17 4	18 0	...
Australian ... „	1	24 1	19 2	16 0
Belgian... ... „	1	...	22 9	19 2
„ (Pickled) „	1	15 8	15 10	14 6
Chinese. . ... „	1	15 0	13 11	13 0
	2	14 0	12 11	11 10
Danish ... ... „	1	30 2	26 6	23 2
	2	29 2	23 5	19 7
„ (Pickled) „	1	...	13 8	14 5
Dutch ... ... „	1	27 9	23 3	19 0
Egyptian ... „	1	10 8	10 4	10 0
	2	10 2	9 10	9 7
Polish ... ... „	1	16 4	15 2	14 4
	2	15 6	...	...
Russian ... „	1	17 5	15 8	14 6
	2	16 6	15 2	13 6
Swedish ... „	1	28 8	21 9	20 0

AVERAGE PRICES OF POTATOES AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Market.		Quality.	Late Varieties. Red Soils. Langworthy and Golden Wonder.	Red Soils. Other.	Other Soils. Langworthy and Golden Wonder.	Other Soils. Other.
			£ s. d.	£ s. d.	£ s. d.	£ s. d.
DECEMBER.						
Dundee	per ton.	1	...	...	.	3 19 0
Edinburgh	,,	1	...	..	8 0 0	4 10 0
Glasgow . .	,,	1	8 0 0	6 0 0	6 19 0	4 8 0
JANUARY.						
Dundee	,,	1	..	..	...	3 16 0
Edinburgh	,,	1	8 10 0	..	8 0 0	4 8 0
Glasgow	,,	1	8 0 0	6 0 0	6 13 0	4 5 0
FEBRUARY.						
Dundee ...	,,	1	.	..	...	3 10 0
Edinburgh .	,,	1	8 10 0	5 5 0	8 10 0	4 4 0
Glasgow ...	,,	1	8 0 0	6 0 0	6 13 0	3 18 0

AVERAGE PRICES OF ROOTS, HAY, STRAW, AND MOSS LITTER, AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Market		Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley.	Straw. Oat.	Moss Litter.
			s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d	s. d.
DECEMBER.											
† Dundee ...	per ton.	1	...	21 8	26 0	131 0 (a) 121 0 (b)	...	85 8	85 8	90 8	52 0
‡ Edinburgh	,,	1			...	132 6 (a) 125 0 (b)	...	71 6 ...	65 0 ..	84 0 .	43 8* 37 8**
‖ Glasgow	,,	1	.	...	.	104 0	109 0	81 0	..	85 0	37 6
JANUARY.											
† Dundee ...	,,	1	..	16 5	20 6	140 0(129 5(b)	..	89 5	88 2	92 6	51 9
‡ Edinburgh	,,	1	.	.		136 11(a) 130 8(b)		70 0 ..	65 0 .	86 3 ...	44 6* 34 9**
‖ Glasgow	,,	1	...	...	..	110 0	115 0	75 0	..	85 0	37 6
FEBRUARY											
† Dundee ...	,,	1		14 3	18 6	145 0(a) 135 0(b)	..	95 0	95 0	100 0	51 0
‡ Edinburgh	,,	1		.	...	137 6(a) 130 8(b)	. .	76 3 ..	65 0	90 0 ..	47 6* 38 11**
‖ Glasgow	,,	1		...	...	110 0	115 0	75 0	..	85 0	37 6

† Quotations for Straw, baled and delivered.
‡ ,, ,, delivered loose in town.
‖ ,, baled Hay and Straw f.o.r.

(a) Baled and delivered.
(b) Delivered loose.

* Dutch.
** Scotch.

Average Prices of Fruit and Vegetables at Glasgow.

(Compiled from Reports received from the Board's Market Reporter.)

Description.	Quality.	December.		January.		February.	
FRUIT :—							
Apples, *British* :		s.	d.	s.	d.	s.	d.
Bramley Seedling per cwt.	1	24	0	20	0	...	
Other Cooking ... „	1	20	0	14	0	...	
Imported :							
Californian ... per case.*	1	13	9	13	6	12	6
Oregon ... ... „	1	16	0	16	0	15	3
Other American ... „	1	14	0	11	9	11	9
Pears, Californian ... per ½ case.**	1	10	2	16	0	16	2
VEGETABLES :—							
Beet ... ... per cwt.	1	7	0	7	0	7	2
Brussels Sprouts ... „	1	23	2	29	0	30	8
Cabbages-							
Savoy ... ... per doz.	1	2	0	2	0	2	0
Red ... ... „	1	3	6	...		...	
Carrots ... ... per cwt.	1	7	0	7	3	7	5
Cauliflowers, French per doz.	1	4	8	4	6	4	6
Celery ... ... per bunch.	1	2	7	2	5	2	3
Greens ... ... per doz.	1	1	0	1	0	1	0
Leeks ... per doz. bunches.	1	4	2	4	2	4	8
Onions—							
Spring .. ... per bunch.	1	...		...		0	8
Dutch ... ... per bag.‡	...	...		8	6	8	6
Valencia ... ... per case.†	1	10	0	11	0	12	8
Parsley ... ... per cwt.	1	20	0	29	0	49	0
Parsnips ... ... „	1	8	8	8	9	7	9
Rhubarb ... ... „	...	...		44	0	32	6
Tomatoes, Canary ... per lb.	1	0	4½	0	5¾	0	7½
Turnips ... ... per cwt.	1	2	6	2	6	2	6

* 40 lb. (approx.). ** 20 lb. (approx.). † 9 stone (approx.).
‡ 7½ stone (approx.).

Average Prices of Fertilisers at Glasgow and Leith.

(Compiled from Reports received from the Board's Market Reporters.)

Description	Guaranteed Analysis.	December Glasgow	December Leith	January. Glasgow.	January. Leith	February. Glasgow	February. Leith.
	%	per ton £ s d	per ton £ s d	per ton £ s d	per ton £ s d	per ton £ s d	per ton £ s d
Nitrate of Soda	N 15½		13 10 0		13 10 0		13 5 0
Sulphate of Ammonia (Neutral and Granular)	N 21	12 9 0	12 12 5	12 12 0	12 15 0	12 15 0	12 18 0
Superphosphate	S P 30	3 0 0	3 0 0	3 1 3	3 2 6	3 2 6	3 2 6
"	S P 35	3 6 3	3 6 3	3 7 6	3 8 9	3 8 9	3 8 9
"	S P 38	3 8 9	3 12 6	3 8 9	3 15 0		3 15 0
Bone Meal Home	N 5, I P 40	8 10 0		8 10 0		8 10 0	
" " —Indian	N 3¾, I P 45	9 0 0		9 0 0		9 0 0	
Steamed Bone Flour	N 1, I P 60	6 15 0	6 5 0	6 15 0	6 5 0	6 15 0	6 1 3
Basic Slag	T P 22	*2 4 6		*2 4 6		*2 4 6	
" "	" 24	*2 7 6		*2 7 6		*2 7 6	
" "	" 26	*2 11 6	**2 13 6	*2 11 6	**2 13 6	*2 11 6	**2 13 6
" "	" 28	*2 15 0	**2 17 0	*2 15 0	**2 17 0	*2 15 0	**2 15 6
" "	" 30	*3 0 0	**3 2 0	*3 0 0	**3 2 0	*3 0 0	**2 18 3
" "	" 40		†3 10 0		†3 10 0		†3 2 6
Sulphate of Potash (on basis 90 per cent sulphate of potash)	Potash 48 6	10 2 6		10 2 6		10 2 6	
Sulphate of Potash	" 50		10 2 6		10 2 6		10 2 6
Muriate of Potash (on basis 80 per cent sulphate of potash)	" 50	8 5 6	8 0 6	8 5 6	8 0 6	8 5 6	8 0 6
Potash Salts	" 20	3 2 6	3 1 0	3 2 6	3 1 0	3 2 6	3 1 0
" "	" 30	4 8 0	4 8 0	4 8 0	4 8 0	4 8 0	4 8 0
Kainit— In bags	" 14	2 15 6	2 14 0	2 15 6	2 14 0	2 15 6	2 14 0
In bulk	" 14		2 11 6		2 11 6		2 11 6
Ground Mineral Phosphate— Finely ground	I P 60	2 10 0		2 10 0		2 10 0	
North African	I P 56		2 10 0		2 10 0		2 6 3

Abbreviations —N = nitrogen, S P = soluble phosphate, I P = insoluble phosphate, T.P. = total phosphate

* Carriage paid (4 ton lots) to Ayrshire and Renfrewshire; quotations for delivery in Lanarkshire 2*s.* per ton higher

** English Slag, carriage paid to stations in the Lothians † Belgian Slag at Leith

AVERAGE PRICES OF FEEDING STUFFS AT GLASGOW AND LEITH.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	December.		January.		February.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	12 17 0	12 11 0	13 1 3	12 15 0	12 8 9	12 3 9
Foreign	12 4 0	...	12 9 5	...	12 10 8	...
Decorticated Cotton Cake	...	...	12 2 6	..	12 0 0	...
Undecorticated Cotton Cake—						
Bombay (Home-manufactured)...	7 0 6	6 16 6	6 18 9	6 12 6	..	6 6 10
Egyptian (Home-manufactured)...	8 0 0	...	7 12 6	...	6 18 9	...
Palmnut Kernel Cake	9 10 0	.	8 19 5	...	8 15 0	...
Coconut Cake ...	11 4 6	...	10 15 0	...	10 9 0	...
Groundnut Cake— Undecorticated	*8 19 0	..	*8 13 9	...	*8 7 6	...
	**9 6 0	**9 5 0	**8 18 9	**9 5 0	**8 18 9	**8 2 6
Maize Germ Cake—						
Home	11 0 0	.	10 15 0	..	10 17 6	...
Foreign	11 5 0	.	10 10 0	.	10 5 0	...
Maize Germ Cake Meal	11 10 0	.	11 3 9	9 15 0	10 11 3	9 15 0
Bean Meal	12 10 0	12 0 0	12 11 8	12 0 0	11 18 9	12 0 0
Maize Meal—						
Home Manufactured	11 1 0	..	10 7 6	...	9 16 3	...
South African Yellow	9 12 6	9 10 0	9 0 6	9 10 0	8 6 3	8 15 0
South African White . ..	9 0 6	..	8 13 2	...	8 2 6	...
Rice Meal	7 9 0	.	7 0 0	...	7 5 0	...
Locust Bean Meal ...	10 12 0	9 0 0	9 19 2	9 0 0	9 19 5	8 17 6
Locust Beans (Kibbled and Stoned)	...	8 5 0	...	8 5 0	...	8 2 6
Maize Gluten Feed (Paisley) ..	9 12 0	..	9 12 6	...	9 10 0	...
Maize ..	†9 14 6	9 4 0	†9 7 6	8 15 0	†8 17 6	8 6 3
	‡9 10 0	...	‡8 18 2	...	‡8 12 6	...
Oats, Canadian— (No 2 Feeds)		...	9 10 0	...	9 5 0	...
,, Plate	..	...	8 15 0	..	9 2 6	...
,, Home ...	9 8 4	8 15 0	10 5 0	8 15 0	9 16 3	8 13 9
Barley (Feeding) ...	9 4 0	9 15 0	9 1 3	9 5 0	9 5 0	8 13 9
Barley Bran	9 7 0	...	9 5 0	..	9 0 0	...
Malt Culms... ...	7 5 6	..	7 1 3	...	7 6 3	6 0 0
Distillery Mixed Grains—Dried	9 0 0	9 10 0	9 5 0	9 10 0	8 17 6	9 10 0
Brewers' Grains—Dried	9 0 0	8 5 0	8 16 3	8 5 0	8 12 8	8 5 0
Distillery Malt Grains—Dried ..	8 10 0	...	8 11 3	...	8 14 4	...
Wheat—						
Middlings (Fine Thirds or Parings)	9 5 0	8 7 6	9 0 11	8 5 0	8 7 2	7 17 6
Sharps (Common Thirds) ..	7 5 0	7 10 0	7 4 5	7 10 0	7 1 11	7 6 3
Bran (Medium) ...	7 16 6	7 14 0	7 18 2	8 0 0	7 10 8	7 16 3
,, (Broad) ...	8 2 0	8 10 0	8 3 2	8 15 0	7 18 9	8 11 3
Feeding Treacle .	7 5 0	8 0 0	7 0 0	7 15 0	7 5 0	7 3 9
Crushed Linseed ...	...	..	27 10 0	...	27 5 0	...
Fish Meal	...	18 15 0	22 0 0	18 15 0	20 13 9	18 *7 6
Beans—						
China	11 4 0	...	11 8 2	...	11 2 6	...
English	...	...	12 10 0	...	12 1 3	...
Sicilian	11 1 0	..	11 5 8	...	10 19 5	...

* 37 per cent. Oil and Albuminoids. † Plate.
** 40 per cent. Oil and Albuminoids. ‡ American, No. 2 Mixed.

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IMPROVEMENT OF CATTLE IN IRELAND THROUGH STATE AID.

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Royal Dublin Society.—Early in 1887 the Royal Dublin Society applied to the Imperial Government for financial assistance towards the cost of a scheme for promoting improvement in the breeds of cattle and horses. Mr. Arthur J. Balfour (now Lord Balfour), the Chief Secretary for Ireland at that time, supported the application and induced the Government to contribute £5,000 in aid of the scheme. Subsequently, under the Probate Duties (Scotland and Ireland) Act, 1888, this contribution became an annual grant to the Society, who expended the greater portion of the amount on the improvement of cattle in Ireland.

This grant placed the Royal Dublin Society in a unique position, as it was the only body in the United Kingdom entrusted with the administration of Government funds for the improvement of cattle and horses. Every credit is due to this Society for its pioneer efforts in the direction of cattle improvement, as the scheme then formulated has been adopted as the basis of all similar projects subsequently undertaken elsewhere in the British Isles.

The chief feature of the scheme was the award of premiums to owners of selected pedigree bulls subject to compliance with the following conditions :—

(*a*) to keep the bull for a year at a centre approved by the Society, usually the owner's farm ;

(*b*) to charge a low service fee; the Society fixed a maximum ;

(*c*) to reserve the service of the bull for cows the property of small farmers, the bull owner being permitted to use this sire on his own herd also.

The selection of bulls for premiums was made at the Society's Spring Show and Sale in 1888 and also at local centres throughout the country by inspectors appointed by the Society, but as the local centres were found to be unsatisfactory they were abandoned after the first year. In the following year it was decided to have only one centre for the selection of bulls, namely, the Spring Show held in the Society's grounds at Ballsbridge, Dublin, and this arrangement continued as long as the Society's scheme was in

operation. Residents in the various counties in Ireland who wished to be selected to keep premium bulls applied to the Society, and those applicants whom the Society approved for the purpose purchased at the Ballsbridge Shows bulls passed thereat as suitable for premiums. In some cases the applicants chosen by the Society were breeders of pedigree cattle who had brought their animals to sell at the Dublin Show and who took back one of the selected bulls.

The judges at the Spring Show acted as inspectors for the purpose of the Society's scheme, and they provisionally selected a large number of the best bulls in order that the approved applicants for premiums should have a wide choice of suitable animals.

During its continuance this scheme had a very beneficial effect, inasmuch as (1) it improved the cattle in districts in which pedigree bulls had not been kept before, and (2) it educated many farmers as to the advantage to be gained by breeding from pedigree stock—indeed it proved to be the stimulus which induced a large number of tenant farmers in Northern Ireland to establish small pedigree herds of their own. The administration of this annual grant of £5,000 was handed over by the Royal Dublin Society to the Department of Agriculture early in the year 1902.

Congested Districts Board.—The Congested Districts Board, with jurisdiction over all the counties along the Western Coast, was established in 1892. At that time the Royal Dublin Society's cattle scheme was not considered to be suited to the conditions prevailing in the congested areas and the Board adopted a plan of its own, viz. the purchase by the Board of pedigree bulls, which were sold at less than half the original cost to selected farmers, who repaid the reduced price of the bull in two or three instalments. The purchaser was obliged to retain the bull in his district for two or three years, during which time the animal was to be available for the service of a stipulated number of cows belonging to small farmers at a fee not exceeding *2s. 6d.* per cow. Under this arrangement 1,026 bulls were placed in congested districts by the Board during the period 1891-2 to 1903-4 at a total cost of about £20,670.

Department of Agriculture.—In 1900 the Department of Agriculture for Ireland was established, and amongst the powers and duties conferred on it was the improvement of all classes of live stock. For the purpose of cattle improvement the Department adopted the Royal Dublin Society's scheme, with certain important modifications. The principal differences between the two schemes were as follows:—Under the Royal Dublin Society's scheme the Society alone was responsible for the selection of applicants, the selection of bulls, the making of all regulations and the payment of the premiums, while under the new scheme the Department concerned itself only in the provisional selection of bulls for premiums, and the inspection of these animals at the end of the season when the premiums were being renewed and in the making of general regulations. The selection of persons to keep premium bulls, the making of special regulations, and the payment of premiums were matters reserved to the thirty-three Agricultural Committees which were appointed by the County Councils for the purposes of the Act under which the Department was established. These Committees

were made responsible for the working of all county agricultural schemes, including live stock, and for the administration of the funds allocated therefor. County Councils raised under the Act mentioned a rate for the purposes of live stock improvement and Agricultural Education, and the produce of this rate was supplemented by a grant from the funds of the Department of Agriculture. The increased funds at the disposal of Agricultural Committees and the Department enabled them to extend considerably the operations of the cattle scheme: thus in 1901 the number of premium bulls was 350, and this number had increased to 1,016 in 1921.

The agricultural community were not, however, satisfied that the premium system was producing the maximum results, as the improvement in the cattle throughout the country, although pronounced, was slow, and in many mountainous districts, where the premium system had barely reached, was not noticeable. This was due to the comparatively small influence which 1,000 pedigree premium bulls could exert in a country in which there was in 1921 a total of 42,460 bulls and 1,630,976 cows and incalf heifers.

There were two ways of effecting a further and more rapid improvement of the cattle in the country, namely:—

1. To increase the number of premium bulls at least tenfold, but the enormous cost which this course would have entailed rendered it quite impracticable.
2. To license all suitable bulls.

At meetings of the Council of Agriculture the question of requiring bulls to be licensed was discussed on more than one occasion and a resolution on the subject was brought forward in 1915. Owing to the war, however, and the impossibility of getting legislation of this nature considered by the Imperial Parliament at that time, no action was taken. Immediately on the termination of the war the Council of Agriculture raised the matter again, and in November 1918 adopted unanimously the following resolution:—

> "That with a view to improving the breeding of cattle, and preventing the use of inferior and unsuitable bulls, the Department of Agriculture should take steps to promote legislation having for its object the compulsory registration and licensing of all bulls to be used for service in Ireland."

This resolution was circulated among the thirty-three County Councils and the thirty-three County Agricultural Committees in Ireland, all of whom concurred in the proposal.

The Department then urged on the Imperial Government the necessity for the proposed legislation, but the Government expressed the opinion that any such Bill should apply to the whole of the United Kingdom and not to Ireland alone. As, however, neither the English Ministry of Agriculture nor the Scottish Board of Agriculture was prepared at that time to support the Department's proposal, it was not possible to introduce a Bill in the Imperial Parliament.

Ministry of Agriculture, Northern Ireland.—The Ministry of Agriculture for Northern Ireland was established in 1922. It

realized that, although the premium system had been in operation for thirty-four years and although a marked improvement in the quality of Irish cattle had been brought about by this system, the improvement was too slow, and was not nearly so widespread nor so thorough as was desired, and that if Irish cattle were to be graded up so as to compete successfully with Canadian as well as with British stores the compulsory licensing of bulls was not alone imperative but most urgent. Consequently one of the first acts of the Ministry was to draft a Bill providing for the compulsory licensing of all bulls and, if thought advisable, of boars and rams as well. The draft Bill was considered by (1) the Ministry's Advisory Cattle Committee; (2) the Ministry's Consultative Committee, which represents the six County Agricultural Committees in Northern Ireland; (3) the Executive Committee of the Ulster Farmers' Union; (4) the Ulster Agricultural Organization Society; (5) the Royal Ulster Agricultural Society, and (6) the North-West Agricultural Society, and certain suggestions made by these bodies were incorporated in the Bill before presentation to Parliament. The Bill so revised represented the considered opinion of the whole agricultural community in Northern Ireland and, when brought before Parliament, was passed in July 1922 without criticism. Like most enactments intended to accelerate progress the Act entrenches to some extent on the liberty of the subject. Its restrictions, however, are directed against the careless or indifferent farmer who by keeping an inferior sire would, to a certain extent, counteract the efforts of the State and of local authorities to improve the live stock in his district. It may be observed that Switzerland—the most democratic country in Europe—has had a law of this kind in operation for many years with obviously good results, and without any apparent hardship.

Live Stock Breeding Act (*N.I.*), 1922.—The main provisions in the Act (and in the regulations made thereunder), which came into operation on 1st January 1923, are as follows:—

1. The licensing of bulls of the prescribed age, and the prohibition, enforced by penalties, of the use of unlicensed bulls.
2. The granting of permits to owners who feed bulls for beef.
3. A fee of 5*s.* is charged for a licence for each animal, and the licence remains in force during the lifetime of the animal unless revoked or suspended by the Ministry.
4. All bulls passed as up to licensing standard are tattooed on the ear with a letter and a number, and those rejected with the letter "R" only.
5. An owner can appeal against the decision to reject a bull for a licence. When such an appeal is lodged the animal is inspected by an Appeal Judge who is a breeder of cattle, and not an official of the Ministry.
6. Bulls are inspected at the more important spring bull sales and at local centres throughout each county. Inspections are held twice each year—in February and September.

During the interval between the passing of the Act (July 1922) and the date on which it came into operation (January 1924) the

Ministry adopted every means to make its provisions widely known throughout the six counties. This was done through advertisements and notices in the Press, posters, handbills, and by the distribution of a small handbook or guide to the Act. The Farmers' Union, Co-operative Societies, County Agricultural Committees and other agricultural bodies gave the Ministry every assistance in familiarizing farmers throughout Northern Ireland with the provisions of the Act and the procedure to be adopted for obtaining licences or permits.

Northern Ireland was mapped out into a number of districts in each of which numerous centres were fixed by the Ministry for the inspection of bulls by its officers. In selecting these centres the Ministry endeavoured to ensure that owners would not have to bring their animals a greater distance than three miles. In addition, inspections of bulls are carried out at the Annual Spring Bull Sales, held by the Royal Ulster Agricultural Society at Balmoral, and the North-West Agricultural Society at Londonderry, as well as at several local sales of bulls throughout the six county area.

In its administration of the Act the Ministry has advisedly adopted a cautious and lenient policy. Beginning in 1923 with the rejection of only really low grade bulls, the Ministry at each subsequent half-yearly inspection has gradually raised the qualifying standard of bulls eligible for licences. By this method the small farmer is being educated to the advantages of using good class bulls, and consequently it is expected that in the near future only those bulls will be licensed which are up to the standard now required for premiums.

Since the Act came into operation the percentage of bulls rejected for licences at each inspection was as follows:—

September 1923	... ...	5·7 per cent.
February 1924	... ...	15·4 "
September 1924	... ...	22·5 "
February 1925	... ...	23·0 "
September 1925	... ...	23·0 "
February 1926	... ...	36·0 "

Critics have alleged that the Act has reduced substantially the number of bulls in the country, and that fewer bulls are being reared, but these allegations are refuted by the following figures:—

Total number of bulls inspected in first year, 1923			...	6,838
Do.	do.	rejected	do. ...	629
Do.	do.	licensed	do. ...	6,209
Do.	do.	do.	March, 1926	6,639
Increase in 1926 over 1923				430

These figures show that the number of bulls actually licensed in 1926 (6,639) was 430 more than was licensed in 1923, and was only about 200 less than the total number of bulls (6,838) inspected for licences in 1923. This increase may be attributed to the demand for better bred bulls and to the higher prices now being realized for animals which have been licensed.

In Northern Ireland in 1926 there were 2,211 pure-bred bulls. The number is gradually increasing, and many farmers who heretofore kept cross-bred bulls are now keeping pure-bred animals—thus a greater demand for pedigree bulls has been created.

Appeals.—The Act provides that any owner who considers that a licence has been refused without sufficient cause may lodge an appeal against the Ministry's decision. In such cases the bulls are re-examined by appeal judges, who are all practical farmers and quite independent of the Ministry. These judges are appointed by the Governor of Northern Ireland and not by the Ministry of Agriculture. To prevent frivolous appeals a fee of £2, 2*s*. must be lodged with each appeal, and this fee is returned to the applicant if the appeal is upheld.

Since the Act came into operation 52 appeals were lodged, of which 17 were successful, or approximately one-third of the total.

Cost.—It was at first frequently asserted that the administration of such an Act must be expensive, but this has proved to be quite a misapprehension. Except in all appeal and in special cases for which breeders are employed, the inspections are carried out by three of the Ministry's regular permanent Live Stock Officers, whose time is taken up with this work for about a month during the year.

The annual expenditure in connection with appeal and special cases does not exceed £200, while the average amount received in fees and for special inspections is about £1,000 per annum, which covers the Ministry's outlay under the Act.

The Ministry is convinced that the Act is achieving its object, and that its success is due to the whole-hearted support of the agricultural community. Farmers realize that legislation of this nature was long overdue, and that the slight interference with the freedom of action of unprogressive men will be more than compensated for by the ultimate improvement in the standard of Northern Ireland cattle.

AGRICULTURAL SURVEY OF KINCARDINESHIRE.

DURING the winter of 1925-26 an agricultural survey of Kincardineshire was carried out with the primary object of finding out what use was being made of all land not accounted for by the agricultural returns. It was then discovered that the discrepancy between the total area shown in the agricultural returns and that in the Ordnance Survey of the county was due almost entirely to inaccuracies, many of them fairly large, made by occupiers in estimating the extent of their mountain and heath land used for grazing.

While this work was going on the opportunity was taken of making a detailed survey of four selected parishes in the county. Two of these parishes, so far as their agriculture was concerned, were fairly typical of much of the land on the north and north-east of Scotland. The other two were more or less typical of the land

in the east of Scotland. The object of this latter survey was a two-fold one. It was intended primarily to describe the present state of agriculture in these parishes. Its ultimate object was, however, to throw into prominence the importance of all factors connected with the proper management of the soils, crops and stocks of the farms examined.

The method employed in carrying out this latter survey was briefly as follows:—Every individual farm and holding over 30 acres arable was visited. Information was readily given by the farmers regarding the general methods of management, the kind and qualities of stock kept, the prices these fetched when sold, the yields of grain per acre, and the systems adopted in laying down and manuring the different crops, &c. As far as possible this information was checked by the examination of the stock, stack-yards, fields, &c. On the information thus acquired balance sheets were made up. In these due allowance was made for interest on capital at five per cent. per annum, while an arbitrary amount in lieu of the personal services of the farmer was included in the expenditure side. The resulting figures were stated in terms of profit or loss per acre of arable land. These balance sheets were, of course, not actual in any sense of the word, but as they were founded on information supplied by the farmer and as this information was checked as far as possible by the reporters, they were at least useful in comparing the results of various methods of management.

The net results clearly indicated that there were wide differences in the balance sheets of one farm as against another. To take extreme instances it may be mentioned that the net profits appeared in some cases to amount to as much as two to three pounds per acre, while the net losses on farms of the same size and character were as much as two pounds per acre. Owing to the complicated nature of farming, the numerous branches into which it can be divided, and the inter-relation of these branches one with another, it is a difficult matter to state definitely the reasons for these profits and losses. In a general way it may be said that complete success in farming is due to two primary factors:—

(1) The system or plan of management.
(2) The skill in management.

System of Management.—The system or plan of management has a profound bearing on the financial success of a farm. A suitable system may for instance enable a poor farmer to pull through in difficult times, while a skilled farmer working on a system that is unsuitable either to the farm or to the economic needs of the times may find difficulty in getting ends to meet. For instance, a skilled farmer working a second-rate farm several miles from a station and devoting his energies to grain and potato growing might find it impossible to balance accounts, whereas a neighbour farming in a rather careless fashion, but rearing considerable numbers of both cattle and sheep, might be making fair profits. Ample evidence of this was afforded in the survey. Where there were large yields of grain per acre, or where the land was suitable for growing potatoes of very fine quality, it was customary

to find such land intensively worked. On the other hand in the poorer districts the less the farmer cropped within certain limits, the more chance had he of making a profit. This is shown by the following table, which compares all farms in the parishes working according to the undermentioned rotations.

Rotation.	Profit or Loss per Acre.		
	Parish A (Soil fair).	Parish B (Soil poor).	Parish C (Soil good).
	s. d.	s. d.	s. d.
Five course	− 18 3	−25 6	+28 1
Six course	+ 4 6	− 7 9	+23 9
Seven course easy	+ 16 3	+ 1 1	...
Lothian six course...	...	...	− 6 11

Owing to the smallness of the numbers compared in certain instances, the above results are not statistically beyond challenge. They indicate, however, pretty clearly that long grass rotations, in the poorer districts at any rate, are more suited to the times than short grass rotations and close cropping. The reasons for this are chiefly the following:—

(1) Working expenses are lower.

(2) The rearing of young stock, especially sheep, becomes possible.

(3) Full advantage can be taken of the good effects of wild white clover.

Working Expenses.—Working expenses in a general way are largely composed of labour costs. In the case of such crops as grain and potatoes, labour enters very largely into the costs of production. Comparing the pre-war and present day prices of these commodities and contrasting the rise in prices with the rise in labour costs, it is at once apparent why these crops which require much labour in their production are less likely to yield profits to-day than they were before the war. On the other hand grass-land farming, largely because labour enters but little into the cost of production, because rents have not altered much, and because the products of grass land farming still stand at relatively high price levels, is more profitable than it was before the war.

Sheep Breeding.—When the pre-war stabilised prices of beef and mutton are compared with the prices of to-day, it is noted that both wool and mutton stand at higher levels than beef. Sheep, in other words, have recently been more profitable than cattle. Under North of Scotland conditions it is not unusual for purely arable farms specialising in stock to carry a regular stock of sheep, provided they have sufficient summer grass to keep on the regular stock of cattle as well. Thus, a purely arable farm worked on the five course rotation could not carry a regular stock of sheep as well as a regular stock of cattle. On the six course rotation such a farm might conceivably carry a regular stock of sheep as well as cattle, but the chances are that some extra grass would be required. On the easy seven course rotation there should be abundance of

summer grazing for both sheep and cattle. This in part explains why a fairly long grass rotation fits in with the keeping of sheep.

Wild White Clover.—In districts where long grass rotations are common, wild white clover, partly because of its increasing the grazing capacity of the land, and partly because of its effect in enriching the soil, has a very decided bearing on the prosperity of the various farms.

It may be of interest to compare the results obtained from the balance sheets of two parishes where long rotations are customary.

Profit or Loss per acre—Average of all Farms.

Sheep Comparisons.	*Parish A.*		*Parish B.*	
	s.	*d.*	*s.*	*d.*
Sheep...	+7	9	−0	3
No sheep	−3	11	−10	8
Wild White Clover Comparisons.				
Wild white clover ...	+8	6	−1	9
No wild white clover	−6	5	−7	11

Management of Stock.—This refers purely to the system which the farmer adopts in regard to the management of stock. He may for instance keep breeding mares and sell geldings at five or six years old. He may keep considerable numbers of pigs or he may specialise in poultry. Many different systems were noted, and the following generalisations were made:—

(*a*) Horse-breeding at present prices is doubtfully profitable, especially if it entails the keeping of an unduly large strength of horses on the farm, or if secondary animals only are bred.

(*b*) Cattle-breeding is closely associated with feeding in the poorer districts, but in the cropping districts cattle-feeding predominates. The latter method gives the quickest turnover. The results obtained depend for their success largely on there being a considerable margin between the in-buying price per live cwt., and the corresponding selling price. The method of breeding gives more steady and uniformly profitable results than that of feeding.

(*c*) Dairying where practised was confined to whole milk production. Where this was associated with a retail milk trade, very good results were obtained. Without a retail business the results were only moderately profitable.

(*d*) Sheep breeding was much more common than sheep feeding in all areas. Farmers who did not keep sheep usually let turnips and wintering to flock-masters for much smaller sums than they could have obtained had they kept sheep for themselves. The problem of fencing appears to be one of the greatest obstacles to the keeping of sheep.

(*e*) Pigs and poultry were extensively kept in very few farms only. Such farms invariably showed good financial results.

Rotations adopted in Good Areas.—Cereal growing is often said to be a non-paying concern in these days. But this state-

ment is loose and misleading. Despite low prices and high costs of production, cereal growing may still be profitable, provided the yields per acre are sufficiently high. If the yields per acre are exceptionally high it may be very profitable. The same holds good in regard to potatoes, only it must be remembered that the profits of potato-growing are mainly dependent on the price per ton at the farm. In the crop-growing districts under review some very high yields of grain were recorded, while the prices per ton for the potato crop on certain farms where seed of suitable kinds was being produced were also comparatively high. On the more fertile farms close cropping and high labour costs were frequently associated with very good results. This applies to the best farms only; on all others a longer grass rotation might conceivably be adopted with advantage.

Skill of Management.—Under this heading may be considered all points connected with the management of stock, crops, labour, and business methods

Cattle Breeding.—Very different results were noted comparing individual farms with each other. It was frequently noticed that some farmers managed to market their fat cattle six to nine months earlier than others, and yet obtain equally good prices. Such a result might be due to:—

(1) The skill employed in selecting the parents.
(2) The management of the calf until weaning time.
(3) The feeding of the weaned calf, so that the calf flesh is not lost.

Cattle Feeding.—In the districts under consideration two main methods of feeding were employed. In the breeding districts feeding was a slow and gradual process, and only limited quantities of concentrates, principally oats, were used. In the feeding districts very large quantities of cake up to ten and eleven pounds a day were used, the aim being to effect a speedy fattening process and a consequently quick turnover. In such districts farmers anticipate a considerable appreciation in the price per cwt. of the animal when sold as compared with the in-buying cost. If such a result is obtained then the employment of what might otherwise be termed wastefully large amounts of concentrates can be justified. Otherwise the procedure is doubtfully profitable. In any case it is probable that equally as good results could be obtained by substituting cheaper starchy foods for part of the cake ration.

Sheep Breeding and Feeding.—Here again different farms produced very different results, even when the same class of sheep was kept. Good results were attributed by the farmers themselves to the importance of securing good rams, and to the plentiful feeding of both ewes and lambs in the spring.

Pigs.—On many farms the reporters were told that pigs did not do well, but only in a few instances did pigs appear to receive the same amount of attention as was given to cattle.

Poultry.—Several farms showed gratifying results in regard to poultry-keeping. The best results were obtained where only good laying breeds were kept, and where early hatching was made possible by the use of incubators. On some such farms keeping

200 hens, the gross income from eggs alone amounted to over £5 a week during part of the winter.

Grain Crops.—Considerable variations in the yield of grain were frequently noted. These were in part due to soil, and in no little measure to the skill of the farmer as exemplified by persistent good farming. For instance the approximate yields of grain on three adjoining farms in the same district was found to be as follows:—

Yield per Acre in Bushels.

	Oats.	*Barley.*
Farm A	50	40
„ B	24	20
„ C	48	36

Turnips.—In few instances were bad crops of turnips observed. On one particular farm worked on the five course rotation the turnip crop was more or less of a failure owing to finger-and-toe disease. This disease was very little in evidence during the season 1925. The proportion of crop affected in the districts under review was less than 5 per cent. In other instances the failure of the crop was attributed largely to mismanagement of the field at sowing time.

Potatoes.—On some fertile and well-managed farms where the average yield of potatoes runs between seven and eight tons per acre it was noted that the yields of King Edward potatoes owing to blight were as low as four tons during the past season. Although the crops of King Edwards and other potatoes in recent years have frequently suffered considerable reductions in yield by blight, the recorders found that no steps were taken to combat the disease. Otherwise this crop was very well managed.

Hay and Grass.—Very striking contrasts were frequently observed in connection with the hay and grass crops. In some districts large quantities of Italian rye grass were sown in the grass seed mixtures, while the resultant hay crop was manured with sulphate of ammonia. Little red clover could be observed in either the hay or aftermath, while the second year's grass was poor in the extreme. In other districts where little or no Italian rye grass was used, but where wild white clover was included in the grass seed mixtures, and where artificials were applied with a view to helping the clovers particularly, very good results in the aftermath and subsequent pastures were obtained. Yields of hay varied from less than one ton to over three tons per acre, while similar variations were noted in the grazing capacities of the pastures. Boundary fences frequently were noted as dividing pasture fields the grazing powers of which were as 3 to 1.

Labour.—In order to compare the strength of horse and manual labour employed on the various farms, the basis of acres per shift on an easy six course rotation was employed. Thus on a farm of 144 acres worked according to the above rotation and employing four men, inclusive of the farmer, and four horses, the man and horse equivalent would each amount to 6 acres. In the case of the Lothian six course rotation the figures obtained would have to be

increased approximately by two-thirds. The following table gives some comparisons (rotations identical):—

	Man Equivalent.	Horse Equivalent.	Remarks.
Farm A ...	4·5 acres	4·5 acres	Well run—profits small.
Farm B ...	6 "	7 "	Well run—profits fairly large.
Farm C ...	3·75 "	5·5 "	Exceptionally well run profits very small.
Farm D ...	4·75 "	4·75 "	Loss considerable.

It is interesting to note that in the southern parishes of Kincardineshire labour on farms is extremely well organised and very highly paid. Some instances were noted of cattlemen attending to upwards of one hundred cattle, whereas the equivalent number in other districts would scarcely exceed forty. This comparison is not strictly accurate since the customs in the districts compared show certain differences. They sugggested to the reporters, however, that very considerable savings in labour could be effected by properly planned steadings.

Tractors.—Owing to the stony nature of the fields and the comparatively small size of the farms in the northern parts of the country, tractors were uncommon. In the southern districts some were employed with great advantage. In certain instances they displaced three if not four horses, but in other cases the displacement effected was practically nil.

Business Methods.—Only very general observations could be made. In certain districts many of the farmers were members of a purchasing co-operative society and short credit transactions were customary. Considerable numbers of farmers, however, were evidently working on long credit systems and were practically tied customers of various firms. The sales of cattle, sheep and pigs were effected by auction marts for the most part. Eggs were usually sold to grocers' carts at prices very considerably below those ruling in the large cities. The time spent by farmers in attending ordinary markets varied from less than a day a fortnight in the northern districts to one and frequently two days a week in the southern districts. The time spent at sales had very frequently no relation to the amount of business carried through. Telephones were used only on some of the larger farms. Most farmers were shrewd judges of the value of everything they had to sell, but in the matter of purchasing both manures and feeding stuffs sound judgment was less noticeably displayed.

Education.—In one district where the farming was distinctly superior it was noted that the good results were in very large measure due to the efforts of the College of Agriculture. In this district systematic classes in agriculture followed by numerous experiments had awakened the minds of most farmers to the benefits to be derived from science as applied to agriculture. It may be added, too, that most farmers in this district were very fully conversant with the valuation of manures on the unit basis.

Liming and Drainage.—The shortage of labour during the war

and the recent decline in agricultural prosperity had evidently prevented or discouraged farmers from spending much money on these two forms of improvement. Practically no draining and very little liming had been done within recent years in the parishes under review. The need for either was, however, not so pronounced as might be expected.

Rough Grazings.—Although very good use was frequently made of the rough grazings on a large number of farms, and although these were rightly considered as assets to the farm, in far too many cases farmers did not seem to realise the possibilities of these grazings. Frequently they were improperly fenced, while nothing had been done to improve them by such operations as draining and systematic burning of whins or heather. In no single instance did the reporters come across any attempt being made to improve rough grazings by manurial treatment. Even the manurial treatment of rotation and other grasses appears to be but little practised. That this form of productive expenditure is so little indulged in is very surprising.

Buildings.—The farm buildings were on the whole substantial and generally commodious. In few instances was good accommodation for pigs provided, and lack of proper implement sheds was noticeable in some districts. In the southern part of the county most farm buildings had been planned with a view to labour saving. The number of cottar houses varied from 25 per cent. of the total number of male agricultural workers employed in some districts to 50 per cent. in others.

General Conclusions.—Speaking generally, the agriculture of the four parishes under review reached a high standard. The grain yields even in the poorer parishes were above the averages for the whole of Scotland. The land was generally clean, dry and well managed, while the organisation of labour was very good. Yet in spite of all this the balance sheets, after interest on capital and an allowance for the farmer's services were deducted, were frequently on the wrong side. But the apparent cause of this, viz., low prices for what the farmer had to sell and high working expenses, does not explain why so many farms were able to show a balance on the right side. In far too many instances methods, suitable neither to the farm nor to the existing times, were being blindly followed. In other instances lack of skill of management in some or other of the branches of the farm accounted for losses being made. Greater attention should undoubtedly be paid to the growing of seed potatoes, and to the keeping of sheep, pigs and poultry. On many of the poorer farms better results would be obtained by making use of longer grass rotations. The contrasts displayed by comparing the different farms made it very plain that skill or lack of skill in the management of crops, live stock and labour accounted for wide differences in the results. The benefits to be derived from agricultural education, though widely, are by no means sufficiently, taken advantage of. Lastly, considerable savings could in many instances be made were better business methods adopted. Altogether, high though the standard of farming is in this county, there is yet room for considerable improvement.

FARM ECONOMICS.

SCIENTIFIC experiment and research in relation to crop production and animal husbandry have for at least three generations been carried on with success in Great Britain, and have, in conjunction with the ability and experience of practical farmers, done much to maintain the place that British farming holds in the world. The same cannot be said of the business side of farming. It need hardly be stated that many farmers are good men of business, but their practice has not been codified, nor have the economics of the agricultural industry been investigated with any degree of fulness. British economists have given their attention mainly to manufacturing industry and finance, in both of which activities Britain was pre-eminent throughout the greater part of the nineteenth century. Apart from Ricardo's theory of rent, with its associated "law of diminishing returns," the student of economics at a British University hears or reads little that bears on the fundamental industry of agriculture. This is not remarkable, in view of the paucity of material. Until recently few farmers kept accounts, and while the pressure of the increased income tax has induced a greater number to do so, the practice is not yet as much a matter of course even among the larger farmers as it is among men carrying on urban businesses of comparable size.

Sir Daniel Hall, speaking three years ago on "The Teaching of Agriculture," asked what characterised a good farmer as distinct from a bad one, and his answer was summed up in the one word "management." Hence he went on to say that the basis of the teaching of agriculture was or should be "accountancy."[1] This revolutionary doctrine, which Sir Daniel Hall himself described as "somewhat one-sided," may at any rate serve as an introduction to the brief account that will here be given of certain recent developments in Scotland.

Among the countries where special attention has been given to agricultural economics the United States, Denmark and Switzerland are conspicuous. In each of these countries agriculture fills a larger place in the national economy than it does in Britain, and it is natural that the economic investigation of the industry should have been taken up, whether by voluntary bodies like the Swiss Peasants' Union, by Government Departments or by Universities and Agricultural Colleges. In all three countries the scientific treatment of farm accounts and statistics has yielded results that are of service alike, although perhaps in varying degrees, to the economist and to the farmer. It cannot be said that either in England or in Scotland has comparable progress been made. On the other hand, each country has its own problems, and the best method of dealing with these must be evolved and not borrowed.

An important step was taken in 1913, when the Institute for Research in Agricultural Economics was established at Oxford. During the war, administrative requirements led to the investigation of the cost of production of milk and other kinds of farm produce. The Agricultural Costings Committee, under which systematic

[1] *Journal of the Ministry of Agriculture*, December 1923, p. 802.

investigation of cost of production was carried on in Scotland and Ireland as well as in England and Wales, was set up in 1919, but was dissolved for reasons of economy in 1921, before it had had time to reach results of real value. More recently, various English Universities and Colleges have appointed economic advisory officers, who will study the systems of farm management in their respective areas and take part in teaching principles of economic farm management.[1]

In the Scottish Agricultural Colleges, economics and farm book-keeping form part of the normal course of study, as they do in several teaching institutions in England. Recently, however, in order to bring Scotland into line with modern developments, the Board of Agriculture for Scotland decided to appoint an Advisory Officer in Farm Economics, and funds have been provided for the appointment of officers of a similar kind by each of the Colleges. For the purpose of investigating the whole question with special reference to Scottish conditions the Board appointed last year a Committee consisting of Messrs. H. M. Conacher, J. Row Fogo, C.A., A. C. M'Candlish, G. G. Mercer, J. M. Ramsay, and Professor W. R. Scott, with the following reference:—

> "To examine and report on various methods of farm accounting followed in different countries, and to recommend the one which seems best for ascertaining (1) cost of production, (2) profit (making all due allowances for the difference between the conditions of agriculture and those of other industries).
>
> "To indicate generally what are the principal problems of farm economics, the solution of which might be aided by the collected results of a sufficient number of kept accounts, and whether there is any further statistical information which the Board might profitably collect for the purpose of solving such problems."

The Committee has now presented its report to the Board, and the following summary of it has been prepared for publication.

The Committee begin by distinguishing between two general types of farm accounting—(1) a form of account designed to show the profit or loss on the farm undertaking as a whole; (2) a more analytical set of accounts, in which an attempt is made to isolate the various kinds of operation carried on as parts of the undertaking, the calculation of cost of production often being made a special feature of the analysis. Each of these types of account, if available in sufficient numbers, may form the basis of further calculation and of economic conclusions. Since, however, the second type demands much more labour on the part of the farmer than the first, it is not to be expected that accounts of this analytical type will be readily available. The discussion of the nature and limitations of "cost" accounting in agriculture is postponed to a later part of the report, and the Committee proceed first to consider the simpler form of profit and loss account.

In this connection an examination has been made of the

[1] See "The Study and Teaching of Agricultural Economics," by A. W. Ashby; *Journal of the Ministry of Agriculture*, June 1924, p. 236.

systems of accounting in use in Switzerland and Denmark.[1] As these are countries of small family holdings, the authorities concerned in the analysis of farm accounts have directed their activities mainly (*a*) to the ascertainment of the gross and net return produced by the farm, reckoned from various points of view—individual, family and social, some of which are unfamiliar to the British mind, and (*b*) to estimating the profitableness of the agricultural industry as a whole from year to year. The systems followed in the two countries, while affording useful guidance on many points, exhibit an elaboration that appears to be unnecessary for the purposes contemplated by the Committee.

The system of book-keeping recommended by the Committee need not here be described in detail. It is in fact the method usually followed by Scottish farmers in keeping accounts or by accountants on their behalf. Certain points on which business practice varies, and on which uniformity has to be secured, are discussed at some length, and for the rest it is suggested that any points of difference arising between the persons concerned in collating the accounts should be settled with the assistance of a professional accountant. Attention may be drawn to the recommendation that in all cases Whitsunday should be the date for closing the accounts.

One important matter on which a difference of practice exists is the treatment of interest on capital and earnings of management. Neither of these, say the Committee, can properly be entered in the "outgoings" side of an account. They quote with approval the following passages from Mr. Orwin's work *Farming Costs* (pp. 57-59):—"Interest on the farmer's own capital must always be an allocation of profits; interest on any borrowed capital is a charge against profits; in neither case can it be a charge against cost. . . . Another common error in statements of costs is the inclusion of a charge for the farmer's reward as manager. This again . . . is a matter to be ascertained from the profits. (The salary or wages of a paid manager are, of course, a legitimate charge against costs.)"

The "net return," or "profit" in the wider sense, thus falls to be divided between interest on capital and earnings of management. Here a difficulty arises. The American economists allow five per cent. interest on capital. With regard, however, to Scottish agriculture the Committee say, "It is difficult to suggest any flat rate of interest; any such figure would be more or less conventional and based generally on the analogy of commercial and industrial undertakings. If, however, the figure is put anything like as high as the normal return expected on capital in such concerns, it would probably be impossible to make any allowance for earnings of management. . . . Perhaps then at present it will not be possible to do much more than ascertain which types of agriculture give a relatively steady return and which do not."

For the purpose of inducing more farmers to keep accounts,

[1] The Committee found the monograph entitled "Les Offices de Comptabilité Agricole," published by the International Institute of Agriculture in Rome, of great help in this part of their work.


Sutton's Seeds
The extraordinary sequence of
PREMIER HONOURS
won in 1925 with the produce of
SUTTON'S
PEDIGREE SEEDS
constitutes a record.
NINE FIRST PRIZES
out of 12 First Prizes and the
GOLD MEDAL
for the Best Exhibit of Roots in the Show were gained at the Scottish National Fat Stock Show, Edinburgh, 1925, with the following varieties of SWEDES and TURNIPS.
SWEDES.
Sutton's Caledonian—First and Reserve for Gold Medal.
Sutton's Magnum Bonum—First.
Sutton's Green-top—First.
Sutton's Magnum Bonum (Smallholders' Class)—First.
TURNIPS.
Sutton's Perfection Green-top Aberdeen—First and Gold Medal.
Sutton's Purple-top Aberdeen—First.
Sutton's Selected Foster-ton—First.
Sutton's Imperial Green Globe—First.
Sutton's Perfection Green-top Aberdeen (Small-holders' Class)—First.
In future every packet of 'Sutton's Seeds' will bear this seal and none is genuine without it.
1926
PEDIGREE-QUALITY
Sutton & Sons
Reading
Sutton & Sons
The King's Seedsmen
READING

the Committee think that co-operative action by groups of farmers is desirable. Such groups need not be formed *ad hoc.* Existing farmers' societies, such as branches of the National Farmers' Union, societies affiliated to the Scottish Chamber of Agriculture and Co-operative Societies, might organise the keeping of accounts by their members, and such groups might usefully employ accountants in country towns to help farmers to keep accounts in a suitable form or to give them hints as to how it should be done.

Reference has already been made to the use of farm accounts in Switzerland and Denmark for the purpose of ascertaining the profitableness of the agricultural industry from year to year. The farms dealt with may be classified in several ways—by districts, by size and by type of farming. The Committee recommend that in Scotland the following scheme of division should be adopted:—

(1) The east coast from Berwick to Forfar, with the lowland parts of Perth and parts of Stirling and Lanark. Here arable cultivation is carried on primarily for the sale of the crops.

(2) The north-east lowlands from Kincardine to Easter Ross. Here arable cultivation is carried on primarily for the feeding of stock, and only to a certain extent for the sale of grain and potatoes.

(3) The south-west from the Clyde to the Solway, including Bute and parts of Argyll. Here the chief interests are dairying and cattle-raising, with the production of grain and potatoes in parts of Ayr, Wigtown and Dumfries.

(4) The Southern Uplands and the Grampians for hill sheep farms.

The first three districts roughly coincide with the college areas, and will thus lend themselves to special investigation by the college officers.

It will be gathered from the discussion summarized above that the committee hope for results useful alike to the farmer and to the economist from the examination of profit and loss accounts of a relatively simple type. They believe that in recent discussion of agricultural economics in England and Scotland too much stress has been laid on the analytical or "cost" accounts mentioned at the beginning of their report as the second type. "We have come," they say, "to the conclusion that the ascertainment of the cost of producing individual farm crops by means of scientific accounting must be dismissed for the present . . . except under special arrangements between selected farmers and accounting officials." This conclusion is not reached, however, without a careful examination of the whole question.

In the United States farm accounting has been directed mainly towards the ascertainment of cost of production. This is not unnatural, as North American agriculture is largely associated with the production of staple crops, which are grown over large areas and by a great number of farmers. The data used are not exclusively such as are measured by money values, and in a sense it would be possible to arrive at substantial results by equating the amount of labour spent on a particular field, plus the amount of seed sown and of manures applied, plus a factor for the natural

fertility of the soil, with the actual amount of crop raised; nothing need be stated in terms of money, although normally the money standard is used in comparing the results obtained on various farms.

The question remains whether the "costing" system now used to an increasing extent in other industries can appropriately be applied to agricultural production. In other industries the object of "costing" is directly practical; the manufacturer uses the method in order to fix the price at which he can afford to sell a commodity, or the contractor to determine his estimate for a piece of work. It is true that during the period of control the cost of producing milk was ascertained in order to fix its price; but generally speaking "costing" in agriculture is designed to secure information as to the cost of producing a thing that has already been produced and sold. Apart from this difference of principle, there are certain difficulties, such as the amount of clerical labour involved in a complete analysis of farming operations, and the difficulty of dealing separately with crops that actually form part of a rotation, which seriously limit the possibility of applying the costing system to agriculture. These observations do not, however, apply in the fullest sense to the ascertainment of the cost of feeding live stock or producing milk or any other staple product; in these cases the cost per unit can be ascertained by dividing the total cost by the number of units produced.

Further, if the object in view is the ascertainment of comparative costs, the difficulties indicated above can be to a considerable extent overcome. The committee gives two examples:—(1) the ascertainment, in a period of falling prices, of the cost of producing wheat on the poorer soils and the better ones respectively; (2) the estimation of the difference in costs and return to be expected as the result of substituting sugar-beet for turnips or mangolds. For the purpose of such inquiries it will be enough to concentrate on those points where there is good reason to suppose that the differences will be found. The possibility of eliminating all those factors which in each case can be regarded as common will go some way towards neutralizing the difficulty of isolating one part of the rotation. In any case, however, the ascertainment of the amount and cost of the labour needed for the operations in question presents a difficult problem. The committee recommend that a special inquiry should be undertaken at an early stage of the Board's economic investigations with the object of fixing "the standard of labour required for the whole process of growing and reaping any one crop under 'normal' conditions of soil and weather, soil of a certain quality being taken as a standard."

The Committee emphasise the general desirability of combining the financial data in agricultural inquiries with the results of general economic and technical studies. Thus in an investigation into the cost of feeding bullocks or pigs, account should be taken of the results of research in animal nutrition. It is further of importance to have for each farm that is dealt with the general economic background that is postulated by the American system of cost accounting. The most important particulars are:—

(1) Geographical situation, with distance from main market or consuming centre.

(2) Character of soil; valuation or assessment.

(3) Mode of cultivation, rotation, &c.; this involves a definition of "rotation grass."

(4) Inventory of labour (including members of family working), stock and the more important farm implements.

Notes are given of a special Swedish inquiry held a few years ago into the cost of production of certain kinds of agricultural produce. The data collected resemble those which the American economists regard as important.

Although the Committee deprecate excessive attention being given to the ascertainment of the cost of production of any single crop, they do not wish to be understood as disparaging inquiries into the economy of farm management. They give two examples of comparative inquiries of this nature. The first relates to a number of farms in the State of Indiana, U.S.A. Here the relation of the "labour income" (i.e. the net return less interest on capital at 5 per cent.) to a number of variables, such as extent of holding, return from stock, yield of crops, &c., is worked out so as to give a number of different tests of economic farm management. Some of the correlations established appears to have little practical meaning, but the general results are of undoubted value. The second inquiry is one carried out by the Oxford Institute, and directed mainly towards bringing out the influence of the size of the farm on its economic position, the test ultimately resting largely on the relative efficiency of manual and horse labour on the various farms.

In neither case have the authors of these inquiries endeavoured to ascertain the cost of production of individual crops or of milk or of any kind of live stock. The conclusion is that the main contribution to general economic inquiries made by investigation into costs is that of furnishing tests of the economic use of fixed capital, circulating capital and labour. "The American inquirers seem to be on the right lines when they make the 'labour income,' i.e. the earnings of the farmer above a bare market rate of interest on his capital, the test of management, and ask what practices appear to secure such a return. The 'brain work' is not in the items costed; it shows itself in a happy combination of operations, but of each of these the mind of the farmer does undoubtedly count the cost."

The programme recommended for inquiry in Scotland is the investigation of each of the types of farming mentioned above, by means of farm accounts and statistical information other than financial, to be obtained by issuing questionnaires to farmers willing to take part in the scheme. The economic investigator will endeavour to discover the standard cost of production in any one type of farming. This will to some extent require the keeping of cost accounts in the narrow sense, but it is doubtful, as has already been remarked, how far the keeping of such accounts is possible for the average farmer. Certain special problems arising in connection with various types of farming are then discussed, besides certain general problems—(1) an examination of the relative efficiency with which labour power is used; (2) the determination of the limits of the scale on which a single farm business will be carried on in the different types, measured not merely by the

"size" of the holding, but by the value of the land and the amount of capital invested; (3) an analysis of the different forms in which capital is invested in a particular undertaking: (*a*) land and permanent improvements, (*b*) fixed working capital, (*c*) circulating capital. Since, as already noted, each of the Colleges of Agriculture has within its sphere of work (apart from the crofting counties, which are divided between the West of Scotland and the North of Scotland Colleges) a definite agricultural region, the Colleges will probably wish their officers to concentrate mainly on problems arising in connection with the branches of agriculture most common in their several areas.

PIG IMPROVEMENT.

II. MEETING COMMERCIAL REQUIREMENTS.

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The Inheritance of Commercially Important Factors.—The discovery of the underlying principles of what is known as Mendelism led people at first to suppose that it would soon be possible to build up new varieties and breeds of both animals and plants in which would be concentrated as many good characteristics as possible and from which would be eliminated the bulk of undesirable factors. Further research, however, soon showed the futility of such a hope for the immediate future. It is true that in the case of plants it has been possible by Mendelian methods to build up such a wheat as Yeoman II, possessing the good qualities of very hard grain, strong straw, resistance to rust, &c., each of which qualities has, so to speak, been picked out separately from different and sometimes otherwise insignificant varieties and combined in one new variety. But even yet only fairly simple factors can be combined at will, and a vast amount of pure research must still be done before sufficient information is available to make possible the combination of some of the less easily understood characters.

In the case of farm animals the position is infinitely more difficult for two main reasons. In the first place reproduction in the higher animals can only take place by the breeding together of two distinct individuals, male and female. Most plants possess reproductive organs of both sexes, and seeds formed from the fertilisation of an egg by a sperm of the same individual are as strong and robust as from fertilisation carried out between two separate and unrelated plants. In the animal kingdom it is impossible to produce a "pure line" of descendants from one individual after the desired good characters have been concentrated in it, because in order to reproduce at all it must be fertilised by another individual in which it has been impossible to concentrate exactly the same characters in exactly the same condition.

In the second place many of the most commercially important points in animal production are physiological rather than anatomical, that is to say that they are connected with the way in which an organ of the body works rather than with its structure. And

although it might be possible, for example, to find out just how large and small udders are inherited, it is vastly more difficult to find out how milk yield is inherited, because milk yield is not wholly, if at all, dependant upon size of udder. The secretion of milk is not yet properly understood, but there is reason to suppose that it is probably due to the interaction of several independent factors, and until we know what each factor is, how it is inherited, and what its effect is when inherited along with varying numbers of the other factors, we shall be in the dark as regards using Mendelian methods for building up a special breed containing the maximum of milk producing qualities.

In the case of the economical use of food there is the same difficulty, because this is affected not only by the balance of the various ingredients in the food, but also by the inherent capacity either to digest more of the food that is eaten or to make more use of what is digested. Digestion, like milk secretion, is a much less definite affair than the shape of horns or the colour of the hair, and consequently it has so far been impossible to find out exactly what factor or factors are concerned in its inheritance.

When we come to the actual muscles and bones which make up the various cuts and joints there is more reason to believe that we may soon be able to separate out some of the more important factors, because conformation is one of the things about which Mendelian information was first obtained, but the greatest difficulty to be faced is the fact that environment has a very considerable effect upon conformation as well as heredity. Every breeder of pigs knows that however well-bred a pigling may be, it will develop an absolutely abnormal carcase if it is starved of total food or of any of the essential food constituents. A pig, for example, which is starved of protein will make very little growth in weight and will develop a particularly shallow body, while on the contrary its legs will assume relatively long proportions. Where lime is deficient in the diet, pigs tend to become rather fat and stumpy, and because rickets often set in, the legs appear to be short. Such marked effects of external conditions upon the carcase make it very difficult to find out just how much of any particular point is due to environment and how much to breeding. Until the exact effect of each of these circumstances on conformation is known so that by making corrections for them the conformation points can all be reduced to the condition due to inheritance alone, it will not be possible to begin building up the best conformation points into one breed.

In spite of all these difficulties, however, Mendelism has something of considerable importance to contribute to the assistance of the pig breeder, and this is the value of the progeny test. The essence of Mendelism consists in the observed fact that when, say, a polled bull is mated to a horned cow the offspring will be polled. The reason for this is that although the offspring have inherited horns from the dam and absence of horns from the sire, the polled condition for some reason dominates over the horned condition and no horns are seen. But the animal still has horns in its constitution although they are suppressed, and if it is bred with an animal of the opposite sex which is horned, the chances are that the resultant calf will carry horns in one out of every two cases. If on

the other hand it is mated with a polled animal it will invariably throw a polled calf.

Suppose now that a polled bull is mated with a polled cow. The resultant offspring will be polled as in the previous case, but this time it has not inherited horns even in the suppressed condition. This means that even if it is now bred to a horned animal the calf will in all cases still be polled.

In both cases the offspring of the first cross was polled, but in the one case it might or might not breed true for horns according as to how it was mated. In the second case it would invariably breed true to the polled condition. This produces one of the biggest difficulties that the breeder has to face, because whenever any particular character is "dominant" it may be present either in the true-breeding double condition or in the hybrid single condition, and it is absolutely impossible to tell from external examination which is the case. The only method of finding out is to make a trial mating, and if this is done in the correct way the first result will often supply the answer to the problem.

Yet there is still a large number of breeders who believe that like always begets like, and in fact the present day showyard system is based almost entirely on this assumption. Having first of all decided that an animal has been bred which is of outstanding merit, the breeding test is the only sound way to determine whether or not it will hand on its good qualities to its progeny. While British breeding methods have been largely devoted to following certain empirical fashions in external conformation, our competitors in the pig trade have not only been concentrating on improving those commercial points that we have now shown to possess the greatest money value, but they have also been quicker to see the value of the breeding test as compared with the less reliable selection of individuals.

Scandinavian Breeding Methods.—A description of the methods employed in Denmark and Sweden and of the organisation which correlates the results obtained with their application throughout the country will be found in the last volume of the Journal of the Ministry of Agriculture (3), but it may just be stated here that records of fecundity and breeding qualities are kept by the live stock advisers from information supplied by the breeder, and records of the ability of pigs to grow rapidly on small amounts of food and to produce good bacon carcases are obtained from pig-testing stations. At these stations four piglings from each sow to be tested are placed at weaning in a pen by themselves and the amount of food which they consume and the weekly gain in live weight are accurately recorded. After slaughter the carcase from each pig is carefully measured and points are awarded for the quality. All the figures obtained at these testing stations are carefully totalled, averaged and analysed and are then issued in annual reports.

On account of the number of large tables of figures it is unfortunately impossible to reproduce here a specimen page of these reports, but Table IV shows a selection of the more important headings under which information is actually given for each pen of four pigs.

Any pig breeder who really wishes to study the exact figures of bacon production is well advised to obtain these annual reports, and the writer would be glad to assist by supplying translations of the column headings of the more important tables. The results so far obtained are distinctly interesting.

Danish Results.—Testing in Denmark began in 1907 and figures are available from that year on. Taking the averages of all pigs tested in each year it is found that there is no increase in the percentage of export bacon, but that the points given at judging of firmness of flesh (12·2 in 1910, 12·5 in 1924), form and fulness of belly (10·5 in 1910, 11·1 in 1924), fineness of head, bone and rind (11·9 in 1910, 12·3 in 1924), and particularly form and size of hams (11.0 in 1910, 12.0 in 1924), have all increased. What is of even greater importance is that the amount of food required to produce one pound of gain has dropped in the case of the Landrace or Native Breed from 3·79 lbs. in 1910 to 3·52 lbs. in 1924.

The improvement in individual herds is in some cases even more marked. In 1910 the Daastrup herd had an average figure of 3·60 food units per unit of gain, which was reduced in 1924 to 3·41. In the case of the Hagelbjergaard herd the figure in 1915 was 4·10 and in 1924 it was 3·30, which in itself represents a reduction in the cost of production by approximately 8 per cent.

Perhaps what will most interest breeders in this country will be the comparison between the two pure breeds of Large White and Landrace and the first cross pigs between these breeds which is made possible by the analysis of breed averages as shown in Table IV.

TABLE IV.

Breed Comparisons.

	Landrace.	Large White.	First Cross Pigs.
Age in days to reach bacon weight ...	190	195	182
Lb. food units per 1 lb. gain during test...	3·52	3·55	3·32
Percentage of export bacon	60·1	62·4	61·5
Thickness in ins. of streak	1·06	1·34	1·10
Points awarded for :—			
Firmness of flesh	12·5	13·2	12·6
Form and size of hams...	12·0	13·0	12·8
Fineness of head, bone and rind ...	12·3	13·1	12·7
Length of middle	11·7	10·2	11·6
Thickness and distribution of back fat	12·3	12·1	12·9

The cross bred pigs stand out as distinctly quicker growers, and it is of great interest to note that this is correlated with economy of food consumption, the average of 3·32 food units per unit of grain in the case of the cross pigs being particularly creditable.

In firmness of flesh, form and size of hams and fineness of head and bone, the Large Whites are superior. In length of body the Landrace seems to be the best, but in thickness and distribution of back fat the cross-bred pigs again come to the top.

With a view to obtaining information about the hereditary

value of sires an attempt has been made to tabulate the different offspring of one boar together. A simple comparison of the averages of litters from each boar would seem to be rather misleading, and one would imagine that these tables would be best utilised by comparing the difference between daughter and dam as is now being done in the case of milk records.

One further way in which the Danish results have been tabulated is to draw up a list in which the breeding centres are placed in order of merit as regards the economy of food consumption of their pigs. The best figure recorded for Landrace in 1924 was the extremely low one of 2·98 food units per unit of gain, and there were eighteen pens of Landrace pigs in which the figure was not higher than 3·30. In Denmark the greatest interest is taken in this list, and there is as keen, if not even keener, rivalry to be at the top as there is to win a championship at the Highland and Agricultural Show in Scotland.

There are, of course, cases where it is desirable to improve a herd in some other particular, and in looking round for fresh blood to bring about such improvement, a breeder finds these testing station results extremely valuable. If his sows are, for example, regularly throwing short pigs, he will try introducing a boar from a herd whose figures for length are considerably above the average, and the same would hold good for any other point.

Swedish Results (4).—The results so far obtained from Sweden only cover about eighteen months of testing. Yet not only are they very interesting, but it would appear that they have been analysed more thoroughly than the more numerous Danish figures.

The number of litters tested is probably not yet great enough to bring out any marked difference between the native Lantras and the Large White breeds. The Lantras, however, appear to have a rather better distribution of back fat, while the Large Whites have larger and better shaped hams.

More interesting, perhaps, is the fact that where at least three litters from one herd have been tested, it is possible to get some indication of the lines along which that herd is being specially developed. For example, it is interesting to compare two herds of Large Whites tested in 1924.

	No. of Litters.	Food units per 1 lb. Gain.	Per cent Export Bacon.	Length of Middle.	Thickness of Back Fat.	Thickness of Belly.
				ins	ins.	ins.
Lessebo	3	3·45	63·7	36·0	1·69	1·22
Svalov	8	3·72	63·3	36·1	1·61	1·38
Average for Large Whites	...	3·59	63·3	36·3	1·62	1·32

A third result of interest to the Swedish breeders is that it has been possible to get some information as to the influence of different families and individual animals on the qualities of their descendants. The change in type from the shorter and deeper Large White which was imported from this country at the end of

last century to the rather shallower, but distinctly longer animal that has recently been fashionable in the show ring, has been watched very carefully in Sweden, but until the development of the testing station it was impossible to state with any precision what the effect had been on the bacon pigs of the country. It is now shown that the descendants of two well known boars, Bourne Bar None and Lawford George II, have been distinguished for great length of middle, satisfactory thickness of back fat, and good proportion of lean meat. Against this, however, has to be put the fact that these good qualities have been accompanied by heavy heads and legs, and a high percentage loss both from live weight to carcase, and from carcase to cured bacon. The hams and the belly too have both been poorly developed, a matter of very considerable importance to the bacon curer.

A fourth result from the Swedish station confirms the experience in this country that it is extremely difficult to get a side that is really good in the streak and yet not too heavy in back fat. The most recent report refers to this as follows:—"Table 16 shows that the valuable quality of well developed belly meat is generally accompanied by low slaughtering loss, a high percentage of export bacon and good hams. The well developed belly, however, seems to be accompanied by a greater amount of back fat, which to some extent lowers the classification as long as the latter is chiefly based on the degree of fattening."

So far these results have been analysed along the same lines as in the Danish reports, but the Swedish report goes a step further and has also examined the effect of sex upon the carcases. This effect is most striking, and it would be interesting to see if it is confirmed by the large amount of figures available from Denmark.

In the first place, out of all the experimental animals that were graded at the factory as first class, 69 per cent. were gilts and only 31 per cent. hogs. When the pigs were divided up into three groups according to size the superiority of the gilts was even more marked. Under 198 lbs. only 28 per cent. of hogs were graded as Class I, where the percentage in the case of gilts was 62 per cent. Between 198 lbs. and 214 lbs. the hogs in Class I were 23 per cent. and the gilts 42 per cent. In the case of pigs over 214 lbs. only 12 per cent. of the hogs were 1st Class, whereas even in this heavy class 30 per cent. of the gilts could still reach Grade I. The difference is fully realised when it is remembered that while even in the heavy group the gilts gave 30 per cent. first class, the hogs only gave 28 per cent. in the lightest group. The superiority of the gilts was due to better developed bellies and hams, though the hogs showed a greater daily increase in weight.

Finally, when the figures obtained at the testing station for pure bred animals were compared with those obtained from previous feeding experiments carried out with ordinary non-pedigree pigs from 1908 to 1922, it was found that in the case of the pure bred stock the daily gain in live weight was ¼ lb. greater than with the mongrel stock, whereas the amount of food units required to produce one unit of live weight gain was ¾ lb. less.

Swedish Litter Weighing Scheme.—While the rate of live weight gain, without reference to food consumed, is not necessarily

an indication of commercial value, it would appear from what has just been said that the two are actually related. With this idea in view some authorities came to the conclusion that it would be better to find a method which was at once less complicated and more capable of universal application than sending only a fraction of a litter to a distant testing station. Such a method has been adopted in Scania, the southernmost part of Sweden, and it consists in arranging that the local milk recorder weighs all the pigs in a litter at birth and when they are three weeks old.

It is argued that up to that time the piglings exist entirely on their mother's milk, and that their weight at that time is the best indication of whether or not the sow is a good milker. The number of piglings at birth and the number alive at three weeks old is also recorded, and then a full record is printed of the results for each sow. We have only space to reproduce in Table V the average figures for each herd for the year 1924. The scheme was not commenced until about two years ago, but the number of herds which are collaborating is growing each year.

TABLE V.—SWEDISH LITTER WEIGHING RECORDS.

Average Herd Results for Recording Year, 1924.

			Total of recorded Herds.						
			Number.		Number of Pigs at		Litter weight at 3 weeks.		
	Herd.	Breed.	Sows.	Litters.	Birth.	3 weeks.	Total.	Average.	Dead Pigs at 3 weeks.
							Lbs.	Lbs.	
	A	E	27	54	10·91	7·28	70·0	9·69	33·3
	B	"	3	5	9·60	8·80	75·3	8·58	8·3
	C	"	26	33	11·09	8·45	88·0	10·33	23·8
	D	L	17	28	10·68	8·61	71·6	8·36	19·4
	E	E	10	16	9·81	7·50	91·4	12·10	23·6
	F	"	5	6	11·17	7·00	85·0	12·10	37·3
	G	L	28	43	9·35	7·95	88·3	11·00	14.9
	H	E	7	12	11·67	9·67	119·5	12·31	17·1
	I	"	7	9	9·33	6·89	77·9	11·21	26·2
	J	"	4	7	8·86	6·43	69·7	10 78	30·6
	K	"	6	12	11·67	9·17	96·0	10 55	21·4
	L	"	4	6	10·33	8·50	92·4	10·79	17·7
	M	"	2	4	7·25	7·00	92·6	13·20	3·4
	N	"	3	5	12·00	12·00	124·5	10·32	0·0
	O	"	3	3	9·00	9·00	88·9	9·90	0·0
	P	"	2	4	11·00	9·25	106·3	11·43	15·9
	R	"	43	62	10·87	7·81	85·6	11·00	28·2
Total ...	...	.	197	309	...	...	...	...	...
Average ...	...	...	...	...	10·52	8·03	84·7	10·55	23·7

* E = Large White English Breed. L = Native Breed (Lantras).

From this table it will be seen that, on the average, each sow has borne 10·52 pigs per litter of which only 8·03 were alive at three weeks old. This represents a mortality of 23·7 per cent., or approximately every fourth pig has died before reaching three

weeks of age. The percentage mortality varies in the different herds from 0 per cent. in the case of herds N and O to 37·3 for F and 33·3 per cent. for A. It is stated that this high rate of mortality is possibly to a certain extent associated with the cold winter of 1923-24, as it is reported that in the case of herd R a large number of pigs were frozen to death. Swine fever which occurred in herd A to some extent lowered the average result.

The total weight of the litter at three weeks old is referred to as the "litter weight," and Table V shows that for 1924 the average "litter weight" was 84·7 lbs., while the average weight per pigling at the same age was 10·6 lbs. These average figures are being taken for the present as a standard, and breeders who are taking part in the scheme can see at a glance whether any particular sow is above or below this standard, and they are in a position to talk of an 84 lbs. "litter weight" sow much as one at present talks of a three or a four gallon cow.

In addition to the averages for each herd, however, it has also been possible to analyse the figures in other ways, and Table VI has been compiled in order to show simply some interesting comparisons.

TABLE VI.

	No. of Pigs at		Litter Weight at 3 weeks.		Dead Pigs at 3 weeks old.	Variation lbs.
	Birth.	3 weeks old.	Total lbs.	Average lbs.	%	
Highest and Lowest Weights per Individual Litter—						
Sow No. 18... ...	12	10	178·0	17·8	...	16·5–20·9
" 2... ...	12	12	176·8	14·5	...	11·9–20·2
" 20... ...	10	7	28·6	4·2	...	2·9–4·8
" 37... ...	5	4	24·8	6·2	...	4·8–7·7
Highest and Lowest Herd Averages—						
Herd N	12·00	12·00	124·5	10·3	0·0	...
Herd J	8·86	6·43	69·7	10·8	30·6	...
Difference ...	+3·14	+5·57	+54·8	−0·5	−30·6	...
Average of Large Herds (over 10 Sows) and Small Herds (under 10 Sows)—						
Large Herds ...	10·62	7·88	81·6	10·3	25·8	...
Small Herds ...	10·45	8·52	94·5	11·0	18·5	...
Difference ...	−0·17	+0·64	+12·9	+0·7	−7·3	...
Breed Averages—						
Large Whites ...	10·82	7·73	81·4	10·6	28·6	...
Lantras	9·87	8·21	81·6	9·9	16·8	...
Difference ...	−0·95	+0·48	+0·2	−0·7	−11·8	...
Winter and Summer Litters—						
Winter Litters ...	10·58	7·81	81·4	10·3	26·1	...
Summer Litters ...	10·46	8·24	87·8	10·6	21·2	...
Difference ...	−0·12	+0·43	+6·4	+0·3	−4·9	...

The highest and lowest weights per individual litter emphasise how very easy it is for the cost of a weaned pig to rise far above its market value, and conversely how profitable a sow can be if she can rear a litter of pigs to weigh 178 lbs. at three weeks old.

The figures for highest and lowest herd averages show how important it would be to have similar figures in this country to guide buyers when they are looking round different pedigree herds in search of commercial breeding stock.

That small herds have a lower mortality and a slightly higher average weight per pig than the large ones is in keeping with our experience in this country, but shows that the larger herd owners have plenty of scope for improving their management

As between the two breeds kept in Sweden there is little to choose except that the Large White pigs would appear to be rather clumsier mothers.

From the figures given, the fault with winter litters appears to be the high mortality, although one would have expected so see a much lower weight per pig as well.

The simplification of testing work by reducing it to merely weighing litters on the farm has much to recommend it, because in practice it is likely to become much more popular and widespread than sending animals regularly to a testing station. It also has the merit that it deals with the whole litter and not a fraction only. But to be impartially critical it must be pointed out that the scheme is open to far too much irregularity. The primary objection in the writer's opinion is that the increase in weight of a pig from birth to three weeks old is due to two factors, the quantity and quality of milk which it obtains, and its own inherent capacity to grow slowly or quickly on a given amount of food. While both are of great importance, the results do not tell one whether the credit is due to the sow as a milker or to the pigs as quick growers. It is hoped that it may be possible to tackle this problem by developing a machine to milk sows so that the milk can be measured before being fed to the piglings.

But apart from this the feeding and general management of the sow are most important as regards the size and weight of litter and it is impossible to standardise this on all the farms. The same criticism, of course, applies to milk records, but this difficulty is now being overcome by such investigations as have recently been made by Hammond and Sanders (5), and it may be that a large number of figures must be accumulated before similar corrections can be made for pigs.

In any case there is sufficient scientific ability in this country not only to adopt these commercial methods of our competitors, but to improve very considerably on them so as to adapt them to present requirements. Whether or not this is to be done depends upon whether farmers are satisfied that the present methods of judging stock and recording their pedigree are adequate to supply the information that is required to adjust breeding methods to meet a very intense competition.[1]

[1] This was written before the recent embargo on continental carcases, but the potentialities remain the same.

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THE ECONOMIC ASPECT OF GRADE A (TUBERCULIN TESTED) MILK PRODUCTION.

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AT the present time in Great Britain increasing attention is being concentrated on the provision of a pure milk supply. The desideratum in view may be approached on the one hand by coercive methods, or on the other by offering pecuniary inducement to the people concerned. If the former method is followed it should be carried out without injustice to those engaged in the industry, while in the other case it is necessary to offer remuneration sufficient to overcome the inertia of long established practice, and to compensate for the extra trouble, skill and risk involved. In either case it is important to obtain accurate knowledge of the cost of carrying out the methods prescribed by the bacteriological authorities for the handling of milk.

In order to obtain some information on the producers' side of this question an enquiry has been carried out by the writer in the South of England into the economic aspect of the production of Grade A (Tuberculin Tested) Milk. The progress of the investigation was facilitated by the kind assistance of Dr. Stenhouse Williams of the National Institute for Research in Dairying at Reading, and Mr. J. S. Simpson, B.Sc., Advisory Agricultural Economist at Reading University. Data on the actual costs and returns for upwards of 20 farms producing Grade A (Tuberculin-tested) milk were collected and tabulated; in addition figures for four farms on which full cost accounts were being kept were made available by the kindness of Mr. Simpson. The results of this survey form the basis of the present article.

The additional costs incurred in producing Grade A (T.T.) Milk, over and above those of producing milk of the ordinary commercial standard, fall in the main under four heads:—

(1) Capital outlay necessary on commencing.
(2) Tuberculin tests and disposal of reactors.
(3) Extra labour involved.
(4) Sundry extra costs in dairy, &c.

(1) **Capital Outlay.**—The matter of the conversion of farm premises for Grade A (T.T.) milk merits very careful consideration at the outset. No considerable expenditure is absolutely necessary.

The results attained depend rather on methods than upon the kind of buildings and equipment. It does not follow, however, that it is wise to carry economy too far: provided sufficient capital is available its judicious use may result in the long run in a considerable saving. Well arranged premises will mitigate somewhat the need for close supervision on the part of the farmer, and enable him to attain the results desired with less trouble and worry. More important still is the matter of saving labour. It will be seen from the accompanying Table that on the farms from which particulars were obtained, manual labour accounted for 51 per cent. of the extra cost, while annual interest on the capital cost of conversion of buildings added to that of provision of equipment formed only about 10 per cent. Hence it seems that there is much more scope for economy in saving of labour than in reducing the expenditure on adaptation of the premises.

The position is not quite so simple as this, however. The figure for capital outlay included in the table is only for interest on the capital expenditure, and allows nothing for repayment of capital.

It is thus necessary to make the assumption that the benefit conferred by the improved premises will be permanent, or in other words that a sufficient price margin between Grade A (T.T.) and ordinary milk will be maintained. Also it assumes that if the occupation of the farm by the person carrying out the improvements should terminate, the outlay would be returned either in the price received for the property or else in the form of compensation to the outgoing tenant. In cases of occupying ownership and in cases where a landlord undertakes the capital burden there will be no difficulty. However, where the tenant carries out the alterations and the landlord is unable to undertake any responsibility in the matter, a different situation arises. No claim for compensation for unexhausted improvements in respect of alterations to buildings can be sustained at termination of tenancy unless the consent of the landlord to the alterations has been obtained previous to their being carried out. The position is one which in such cases is controlled very largely by the conditions and the securities of tenure, and landowners have it in their power to facilitate the progress of the clean milk movement either by undertaking the provision of the necessary capital for adaption or by guaranteeing to tenants adequate compensation at termination of tenancy.

The capital outlay necessary or desirable for the production of Grade A milk on ordinary farm premises may be considered under the headings of:—

(*a*) Buildings (byre, milk room, &c.).
(*b*) Water supply.
(*c*) Dairy equipment.

(*a*) Extensive outlay on buildings is seldom necessary. In most cases adequate lighting and ventilation can be secured at trifling cost. The provision of a good floor is the largest item, and it is one which will pay for some thought before hand. The floor should be made to last. No more suitable material than concrete has yet been devised, and the concrete should not be less than four inches in thickness. Unwise economy in this matter, besides giving rise

to continual expense of upkeep after some time, will be felt to a more serious though perhaps less obvious extent in the labour bill.

Both from the point of view of economy of labour and of cleanliness of the cow shed the construction of the floor is of paramount importance. The standing should be as short as possible, having regard to the kind of cows kept. There should be a considerable drop—six inches or more—from the standing to the level of the gutter. This tends to deter cows from standing back in the gutter, thereby fouling the rear gangway and conveying dung from the gutter on to the standing on their feet. From observation of a variety of types of gutter the writer inclines towards preference for a wide one—at least two feet six inches, sloping slightly towards the rear, with a narrow channel for liquid manure at the rear. This arrangement leaves the dung comparatively dry and it is easily removed, while the liquid manure drains away quickly, rendering the air in the byre sweeter, obviating splashing about of liquid manure,

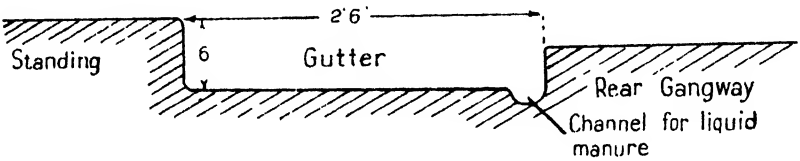

FIG. 1.

and enabling the valuable fertilising material in the urine to be properly conserved. If the gutter is not wide enough, the liquid manure channel becomes choked with dung and does not fulfil its intended function. All angles should of course be rounded. The arrangement is illustrated in section in fig. 1.

Another very efficient arrangement is to dispense with a gutter of the ordinary type, sloping the level of the rear gangway so that

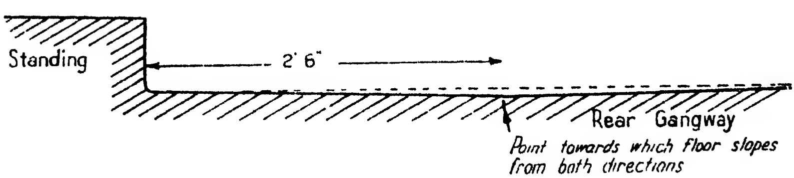

FIG. 2.

the liquid manure flows down a channel free of the solid dung, as illustrated in fig. 2.

The disposal of the liquid manure from the byre presents a little difficulty. The byre is washed down daily, and if the washings enter the liquid manure tank the liquid becomes too dilute and too bulky to be dealt with economically. The whole is often allowed to drain away, and much valuable fertilising material is in this way lost. To avoid this difficulty two-way channels should be provided so that the washing water can be diverted from the tank.

Inside the cow shed maintenance of cleanliness and saving of labour are facilitated by skeletonising stall divisions as far as practicable. It is advantageous to provide single stall divisions so as too prevent the animals as far as possible from standing or lying obliquely and so fouling the bed. The back wall is often coated

with cement up to a height of four to five feet. An even better method, perhaps, is to fasten smooth galvanised sheets to the wall. These give a surface to which dung will not easily adhere, and one which can be kept clean with very little trouble.

The outlay necessary for conversion of the farm buildings for Grade A milk production will of course depend upon the style and lay-out of those previously in use. When the work is put in the hands of contractors heavy charges are sometimes incurred. In one case noticed, the outlay—including only concrete floors and mangers —amounted to £20 per cow. There is no need for any such high expenditure, however. One landowner with extensive experience in this direction stated that an average figure was about £8, 10*s.* per cow. Alterations to lighting and ventilation arrangements form a comparatively small item, and there is plenty of scope for ingenuity in reducing costs. In some cases the desired result can be attained by merely raising alternate ridge tiles and replacing a few ordinary roofing tiles with glass ones. A convenient milk room can generally be devised either by walling off a portion at the end of the cow shed and providing suitable doors, or by utilising some other building in proximity to the cow shed.

The largest item in adaptation is the provision of a suitable cow shed floor, and if material for making concrete is handy this should not be a very expensive matter. In the *Journal of the Ministry of Agriculture* for July 1923 was described the conversion of an old cow shed by putting in a floor of four inch concrete, concrete manger and tubular iron stalls, with other minor alterations, at an inclusive cost of £5, 10*s.* per cow. The work was done entirely with farm labour, the estimated cost of which has been included in the above figure. The metal stall fittings cost £2, 10*s.* per cow, leaving £3 for the flooring, mangers and other alterations effected. In a further instance a concrete floor was laid down entirely with farm labour during slack periods, at a cost—for materials alone—of less than £1 per cow. These examples show that, where material for concrete-making is easily accessible and local skill and labour can be utilised, the expense necessary can be reduced to quite reasonable proportions.

(*b*) The water supply is a matter of much importance, as the maintenance of the necessary bacterial standard, especially in summer, depends very largely on the efficiency of the cooling. A cool and constant supply is a necessity. The most suitable means of supply in most circumstances is from a deep well at the farm premises, from which the water may be pumped into a storage tank by hand or by means of a small petrol or paraffin engine. Care should be taken that the tank is so situated that it is protected as far as possible from outside heat, and the length of piping through which the water must pass from the pump to the cooling room should be as short as practicable.

Supply from a shallow well generally proves unsuitable for Grade A purposes as the water reaches too high a temperature in the warmer months. The same objection applies where the water has to travel some distance in pipes, as in the case of supply from a main or from a windmill situated at a distance from the farmstead.

Where the water is obtained from a deep well at the farm premises the pumping is generally done with a small portable oil engine. This type of engine can of course be used for other farm purposes if desired, and in this way costs may be reduced to some extent. As to the annual cost of running such a plant a rough suggestion may be made on the following lines, say for a herd of 30 cows:—

Fuel and oil	£12
Depreciation	5
Repairs	4
	£21, or 14*s.* per cow.

Half this amount, or 7*s.* per cow per year, may be considered as chargeable to Grade A purposes alone.

Where, as on many farms, such an outfit is already in existence, the actual extra expense of pumping an additional quantity for Grade A purposes would be small, though of course the converse holds good where the outfit is installed specially for Grade A milk production.

(*c*) The cost of extra equipment for Grade A milk production is a comparatively small matter. The usual outfit, consisting of a steam boiler, sterilising chest, double compartment washing trough and a set of domed milking pails, in addition to the ordinary requisites, will cost in the neighbourhood of £50 to £70. The annual depreciation will thus be about £5 to £7. The average depreciation figure for 19 farms worked out at 3*s.* 6*d.* per cow per year, from which a deduction of something like 1*s.* should be made in respect of depreciation on the equipment which would have been used in ordinary milk production.

The capital expense on this score is therefore not a very great matter. One point specially should be noted. The annual cost of fuel for the steam boiler is on the average about £20, while the initial cost of the boiler is not very much more than this amount. In point of fact the fuel cost on one or two farms amounted to as much as £40. It is therefore false economy to pay too much attention to the initial cost in this matter. The fuel consumption should receive first consideration.

(2) **Tuberculin Tests.**—The matter of the Tuberculin Tests is something of a bugbear to the farmer contemplating Grade A (T.T.) milk production, but its effect on actual costs has probably been much exaggerated. The proportion of animals reacting at the first test is of course high in most cases. Over 28 farms in the South of England, results on different farms ranged from 75 per cent. in one case down to only one doubtful reaction in another. The average for 28 farms was 27 reactors per 100 cows in the first test. At the second test the proportion reacting was reduced to 7 per cent.—a figure somewhat inflated by the testing of cattle bought to replace those rejected after the first test.

After the first year herds, with rare exceptions, reach a stable state. Neglecting these exceptions, the average proportion of reactors after the first year of testing was 2½ per cent. per year. This amount is possibly not greater than the proportion which in

an untested herd have to be eliminated in the ordinary course through development of tuberculosis in some form or other.

As to the loss on animals which have to be removed as reactors to the tuberculin test individual experience varies greatly. Many producers are at present able to dispose of them without loss, though this is not likely to be so in the future. In any case, with cattle of the ordinary commercial grade it is unlikely that the loss sustained will amount to more than about £10 per head, representing an approximation to the difference in market value between a milking cow and a barren cow of comparable quality.

The loss sustained on the herd in the first year of testing represents the cost of changing an untested into a tubercle-free herd. It is a capital improvement and as such should be charged over a period of years. If we suppose that the loss on each reacting animal amounts to £10, and that the loss on the first year is spread over 10 years, then the farms included in the investigation above alluded to would show the following average losses :—

One-tenth of the loss in the first year of testing,	5*s.* 3*d.*	per cow
Average loss per year in succeeding years, ...	4*s.* 0*d.*	„ „
Total average loss per year, ...	9*s.* 3*d.*	„ „

This figure is of course only a theoretical one, and in many cases even the comparatively small loss shown would not be fully sustained. So far from being the chief stumbling block to the development of tuberculin-testing, it is seen to be a matter of less importance than even the cost of carrying out the actual test itself.

Figures obtained in the course of the investigation suggest that herds kept out of doors all the year round remain freer from tuberculosis than herds which are housed in winter. Of eight herds kept under the former system the proportion of animals reacting after the first year of testing was practically negligible.

(3) **Labour.**—The manual labour required to carry out the various operations necessary for clean milk production forms by far the most serious item in the extra cost. The cows must be wet-groomed before each milking; the udders must be washed and wiped; the milkers must wash their hands between milking each cow; the use of the domed pail probably retards to some extent the rate of milking; the cow sheds must be cleansed and washed down thoroughly after each milking; the dairy utensils must be thoroughly cleansed and steam-sterilised; it is often necessary to remove the manure to a distance from the cow shed, instead of depositing it just outside the door, as is the frequent practice on non-Grade A farms.

All these operations mean extra labour cost. Grooming and washing the udders of the cows before milking accounts generally for about four minutes per cow per day. This corresponds to 24 hours per cow per year, which at 7½*d.* per hour amounts to 15*s.* The difference in the rate of milking caused by the use of the covered pail and by the practice of washing the hands between milking each cow can scarcely be put at less than one cow per hour, which gives a further extra labour requirement of 24 hours

per cow per year. In addition there are the other factors mentioned, though on the other hand there should be some economy consequent upon the provision of a concrete floor and other capital improvements.

On the whole the extra labour requirement is found to amount to an average of rather more than 100 man-hours per cow per year, or a money equivalent of £3 to £3 : 10*s.* This figure is borne out by examination of costings records compiled by Mr. Simpson; from a comparison of records for Grade A and ordinary farms the labour employed directly in milk production amounted on the average to about 100 hours per cow more on the Grade A than on the non-Grade A farms.

Estimates of the extra labour cost obtained from producers themselves were, curiously, consistently below the calculated amounts. They were based, of course, on the extra staff required, and were found to reach an average £2 : 6*s.* per cow, or about £1 per cow below the calculated figures. However this may arise, the great preponderance of evidence obtained was on the side of the higher figure. It is possible, of course, that some of the extra labour required directly for milk production was balanced by collateral economies in other departments.

It is of course necessary to obtain a superior quality of manual skill in a Grade A dairy. This may involve the payment of higher wages or of bonuses on satisfactory results. It may not be necessary, however, to pay the higher rate for the labour employed, as very often women and boys can be taken on, and for much of the work they prove eminently satisfactory. They are generally more adaptable, more careful, and more enthusiastic over the maintenance of a high standard of cleanliness.

(4) **Sundry Costs.**—Under this heading are included such items as fuel for sterilising, milkers' clothing, laundry, brushes, cleansing materials, towels, cloths or swabs, strainer filters, churn seals, licence, &c. When allowance is made for the cost which would be incurred under this head in ordinary milk production the proportion chargeable to Grade A (T.T.) milk production amounts to something under £1 per cow, or nearly ½*d.* per gallon of tuberculin-tested milk sold.

The largest item here considered is that of fuel for sterilising, and where this is concerned it is worth while exploring avenues of possible economy. Any waste timber can of course be utilised, and the fire can be banked up when steam is not immediately required. It may be possible to secure satisfactory results by washing the utensils thoroughly after the morning milking and sterilising a short time before and again after the afternoon milking. It would then be unnecessary to start the fire until after mid-day, and considerable economy would result.

Returns.—The contention is sometimes put forward that the practice of tuberculin-testing tends to lower the average yield of a herd. It is often the case that very heavy yielders react and have to be disposed of. On theoretical grounds it might be expected that owing to the strain on the constitution of such animals they will be more likely to contract tuberculosis. This argument is not a sound one, however. Since the herd is kept practically free from

tuberculosis, the danger of infection is minimised, and whereas in an untested herd a proportion of the heavy yielders may succumb to the disease and have to be disposed of at little more than hide price, in a tested herd they may perform years of useful service owing to the prompt removal of potential sources of infection.

It may be argued that the use of the covered pail tends to diminish the quantity of milk obtained. Some degree of awkwardness certainly attends the use of some of the common patterns. A certain twist of the wrist is necessary, increasing the effort required though preventing that clumsy pulling of the teats which is a common fault of the unskilful milker. From the writer's observation it would seem too that a certain quantity of milk is lost through the carelessness of milkers in not directing the stream of milk accurately into the opening in the pail. No doubt there is some little difficulty in this respect, particularly with short-teated cows, and with those from which it is only possible to draw the milk in short sharp jerks instead of a steady stream.

A consideration of the yields accurately obtained from Grade A. (T.T.) herds may give some answer to these questions. The average annual yield of 24 herds was 613 gallons per cow. This figure must not be compared directly with recording society figures. The former was obtained from records of the milk sold during the year, added to the estimated quantity used on the farm for various purposes, and the total quantity of milk was divided by the average number of cows in the herd during the year. The result of this method of computation may be more than 100 gallons per cow below the recording society figures for the same herd. It should be observed also that something like half the herds dealt with were badly affected with contagious abortion, and in one or two instances the average yield had declined by almost 200 gallons per cow due primarily to this disease.

With these points in mind the results are seen to be quite creditable. In four cases an average of over 700 gallons was reached, while second place in one recording society for the year 1924-5 was secured by a tuberculin-tested herd with a society average of 9,836 lbs. (milking three times a day).

These figures show that at all events good yields are quite possible under Grade A. conditions, and the proposition that there is any diminution of yield is, to say the least, problematical.

A statement of the average costs and returns for the farms included in the investigation is shewn in the accompanying table. The extra profit is seen to be small in view of the trouble and risk involved, though it may be well to stress one or two points in connection with the figures adduced. Thus, if the producers' own estimates for the extra labour requirement are accepted an additional profit of about £1 per cow would be shown. The figure for loss in reacting animals is a fictitious one, and, while it may in odd cases be exceeded, in others it is not sustained at all. Tuberculosis takes continual toll in untested herds, a proportion of animals becoming "wasters" and have to be sold at a very low price, while the disease works unseen in bringing about chest troubles, lowering the yield of affected animals, shortening the average length of useful life, and thus increasing the annual depreciation on the herd.

These insidious effects are not fully allowed for in the table. Further, it should be possible to effect economies in the various incidental expenses, particularly in the direction of the cost of fuel for sterilising the utensils.

Making all allowances, the present conventional price margin of 3*d.* per gallon leaves little pecuniary inducement to milk producers to enter the trade in Grade A. (T.T.) milk. At the present time, however, it behoves them to be on the alert for signs of a tendency towards over production of milk, and in the event of this development it may well be advantageous to have secured a footing within the confines of a more restricted market.

Extra Cost of Producing Grade A (T.T.) Milk.

	Average Cost per Cow.	Average Cost per gallon of T.T. Milk sold.	% of Total extra Cost.
	£ *s.* *d.*	*d.*	%
Extra Labour	3 7 8*	1·46	51
Depreciation on Equipment	0 2 6	0·05	2
Interest on Capital (Conversion) ...	0 13 4	0·29	10
Veterinary Fees (T. Testing)	0 14 0	0·30	10
Sundry Dairy Expenses	0 18 11	0·41	14
Water Supply	0 8 2	0·17	6
Loss on Reactors...	0 9 3	0·20	7
Total extra Cost	£6 13 10	2·88	100
Extra Returns (at 3*d.* per gallon on T.T. milk sold)...	£6 19 4†	3·00	
Profit	£0 5 6	0·12	

* This figure is reduced to £2, 6*s.* if the producers' estimates are taken.
† Corresponding to 557 gallons of Tuberculin-tested milk.

THE BIOLOGIST ON THE FARM.—No. XXII.

By Professor J. ARTHUR THOMSON, M.A., LL.D.

The Plant Wizard.—No apology is needed for referring to the recent death of Luther Burbank, the veteran genius-gardener who made so many "New Creations" as he called them, like the Stoneless Plum and the Shasta Daisy, the quick-growing Paradox Walnut, and many different berry-crosses like the Logan Berry and the Phenomenal Berry. The first hit he made was a very excellent potato, and when he died the other day, at the age of seventy-seven, he had been working for nineteen years at producing a spineless cactus. It would be of great value if the cactus, which grows in desert places where nothing else will grow, could be made available as fodder for cattle; and Burbank had almost succeeded. It must

be very difficult to eradicate spininess from a cactus, as difficult as getting rid of original sin in man, for we read that even after nineteen years of breeding an occasional spine would present itself.

Burbank was brought up on a farm, and he worked quietly for over fifty years in his Garden of Eden at Santa Rosa, across the bay from San Francisco. He was an unambitious, shy, sensitive man, not much of a botanist or biologist in the conventional sense, but with a flair for detecting promiseful new departures or variations. By crossing or hybridising, and in other ways, he tried to provoke what he called "perturbations" in plants, and when he got something good agoing he was rigorous in burning everything else. There was nothing peculiar in his method, which was simply the sifting or winnowing of the new departures which he observed or provoked, but he had an approach to genius in detecting the first tentatives towards something desirable. He had the breeder's intuitive vision of crosses that were likely to reward, but he sometimes made hundreds of different crosses without getting any distinct advance. He was not a great man of science, but he had great delicacy of sense, boldness of adventure, infinite patience, and a profound belief in the importance of elimination. His epitaph might have been: Test all things, and hold fast that which is good. He was an inventor rather than a discoverer, an Edison in the garden. But he enriched the world with his "New Creations."

The Hope of the Future.—This over-worked compliment has been paid to many lines of life, but it was with a thrill of glad surprise that we heard it applied the other day to the entomologist! In an article by Dr. L. O. Howard, chief of the Bureau of Entomology in the United States Department of Agriculture, we read: "It has become perfectly plain that if human beings are to maintain their hold on this globe, if they are to continue to exist, they must learn to control insects. So the entomologist has risen in our esteem. In him and the results of his work lie our hopes for the future comfort, happiness and prosperity, and even the very existence, of mankind." In Great Britain the attacks of insects are marked by moderation as compared with what occurs in warmer countries, yet we suffer considerably from Aphides, Bean weevils, Crane-flies, Diamond back moths, Elaters, Flea-beetles, Gout-fly, Hypodermas, and so on for the other letters of the alphabet. Insects destroy what is growing and devour what is stored; they attack domestic animals and man himself; they are vehicles of disease; their injuriousness is as incalculable as their usefulness. But when we pass from a small, highly controlled, and often cold country like Great Britain to an immense and often warm country like the United States, often defiant in its vastness, the importance of insects increases cumulatively. When vast areas are under cultivation for some particular crop, such as cotton, there are terrifying possibilities of overwhelming multiplication. This is particularly true when an insect pest is introduced or introduces itself from elsewhere and runs riot in temporary freedom from its natural enemies and in the enjoyment of a new abundance of food. Thus the Cotton-Boll weevil passed from Mexico to the southern United States and has done appalling damage in the Cotton belt. Similarly with the Gypsy moth, which was introduced into America

from Europe about 1868, and has been terribly destructive to trees, from which the caterpillars sometimes eat off almost every leaf. So with the Codling moth, the Corn-borer, the Japanese beetle, the Mexican Bean-beetle; and there are many other instances of the disasters that follow the discovery of a new abundance and a partial escape from the severity of the struggle for existence. We begin to understand why the entomologist is the hope of the future. Dr. Howard goes on to tell us that the annual loss by fire in the United States is 143,600,000 dollars, but the annual loss due to insects is 800,000,000 dollars. Insects destroy 10 per cent. of the animal products, 20 per cent. of the fruits, and 22 per cent. of the wheat. "It has been estimated that the money loss from the work of insects in the United States exceeds two billions of dollars yearly. To put it in other words, insects in the States nullify the expended labour of a million men." So there should be a living wage for the economic entomologist!

Disease-Animals living in Plants.—A fine instance of wheels within wheels is disclosed by the investigations of Prof. H. B. Fantham and Dr. Annie Porter on the presence of very simple animals (Herpetomonads) in the milky juice or latex of certain fig trees and spurges. The number of infected plants (*Ficus edulis* and *Euphorbia striata* at Johannesburg) was very small, and the intruders did not seem to be doing any harm. The minute Herpetomonads (belonging to the simplest animals or Protozoa) are best known as parasites in the food canal of insects, and it is probable that monad-carrying insects inoculated the parasites into the plants. Marks of bug-punctures were found on the spurge, and green flies, species of Lucilia, were seen on the fig leaves. One of the monads in question causes skin sores (kala-azar) in man and dogs, and it is very interesting that there should be a possible natural reservoir of these inimical microbes in the milky juice of plants.

Polar Pastures.—A political authority, who should have known better, spoke recently of agriculture as being parasitic on industry, whereas if there is any parasitism involved (to us the concept does not seem to fit), it is the other way round. Agriculture is the fundamental industry and fishing comes next. Therefore as the world becomes crowded, it becomes increasingly important to promote more photo-synthesis, in other words, to grow more plants. For plants are the only creatures that can as yet make large quantities of food out of air and soil water. Perhaps the chemist can do it theoretically, for we have heard of a laboratory where the students sweeten their afternoon tea with sugar synthetised from carbonic acid and water. But the chemist cannot as yet give us an artificially produced breakfast, and we have to be doing with porridge and its various transformations, such as eggs and bacon. Thus we repeat the words of Jonathan Swift, perhaps with a deepened understanding: "Whoever could make two ears of corn or two blades of grass to grow upon a spot of ground where only one grew before, would deserve better of mankind and do more essential service to his country than the whole race of politicians put together." Those who share these sentiments must have been interested in what the explorer Stefansson has been saying

recently in regard to "Polar pastures." He estimates that north of the wheat line there are three thousand million acres which might form grazing land for reindeer and musk-ox. The reindeer introduced into Alaska from Siberia between 1892 and 1902 have formed great herds, which have been doubling in number every three years. Reindeer yield everything, and the musk-ox would yield fine wool as well as flesh—which is not musky if properly handled. Mr. Stefansson calculates that vast Polar pastures of the North, covered with grass or with lichen, would support a hundred million reindeer and five times as many musk-ox with a total annual meat production of 55,000,000,000 pounds. We should have thought that a further reduction of the birth-rate was not less practicable than polar agriculture, but we admit that this is an arm-chair reflection. "Why do the people so strive and cry," the old poet asked. "They will have food and they will have children; and they will bring them up as well as they can." So we must hie to the Polar pastures.

The Survival of the American Bison.—Twenty-eight years ago the number of American Bison had dwindled to about a thousand, and extinction seemed imminent. But success rewarded the plan of placing remnants of the dwindled herds in large reserved areas in Canada and the States, and the numbers soon rose to several thousands. Naturally enough the reservations have become too small, for each bison requires many acres, just as a sheep does. (Perhaps a hundred sheep can be supported on a thousand acres of hill pasture in Scotland.) Thus it has been necessary to kill a good many and transport others. Last year about 1,600 were transferred to Wood Buffalo Park in the North-West Territories—about 700 miles by rail and water, with only eight casualties. This is all very creditable, but Dr James Ritchie calls attention to a scientific drawback. In Wood Buffalo Park there was a herd of about 1,500 "wood buffalo," a remnant of a wild herd, marked off from the "plains buffalo" of the reserves by larger size, darker colour, more dense and silky hair, larger and more incurved horns. It is uncertain whether the differences between the two races are due to innate variation emphasised by being kept apart or to environmental influence. Dr. Ritchie's point is a shrewd one, that instead of mingling the 1,600 "plains buffalo" with the 1,500 "wood buffalo," it would have been better to have transferred the former to an area similar in latitude, vegetation and climate to Wood Buffalo Park, but isolated from it. Thus "the wood buffalo race would have remained uncontaminated, and time would have shown whether in the new environment the plains buffalo would have assumed the distinctive characters of the wood buffalo. Had it turned out that these characters were wholly environmental, as they may well be, an interesting biological correlation would have been proved, and no objection could then have been taken to fortifying the wood buffalo herd by the addition of plains individuals."

Transport of Nematodes by Flies.—Many of the threadworms or Nematodes do much harm, and everything that bears on their distribution is of interest. It has been shown by Aubertot and others that the larvæ of the common Rhabditis may be carried

from one place to another on the bodies of flies, and Menzel has recently tested this. He found some bat's dung to be swarming with threadworms and also with larval Diptera. When flies emerged in the course of time he carefully examined them, and found that their legs showed little white spots. One of these, moistened in water, yielded forty Rhabditis larvæ. Two house flies were placed on the dung and in a very short time some of the larval Nematodes had effected fixation. They are carried about till the fly settles on another suitable place. and they can survive being dry for two days or more. Here then is another instance of the linking of lives together—bat, fly and threadworm.

Mite in Grasshoppers.—When it was shown by Rennie, White and Harvey in their joint paper of 1921 that a mite (now called *Acarapis woodi*) parasitic in the tracheæ of the hive-bee was causally associated with the so-called "Isle of Wight" disease, the case was unique. It appears, however, that the occurrence of a mite in the tracheæ of a grasshopper was noticed in 1914, though not published, by Mr. C. C. Hamilton, a student at the Kansas Agricultural College. Now we have in the *Annals of the Entomological Society of America* (1925, xviii, 35-44) an account of this mite, which is a frequent inmate of the tracheal system of two kinds of grasshoppers, *Hippiscus apiculatus* (Harris) and *Arphia carinata*, Scud. It is a Tarsonemid mite, named by H. E. Ewing *Locustacarus trachealis*, with some resemblance to the bee Tarsonemid *Acarapis woodi*. In both sexes there is a complete absence of the fourth pair of legs. Mites and eggs occur together in the principal tracheæ and air-sacs, especially in the thoracic region and anterior abdomen. The infestation may be so severe that certain tracheæ and air-sacs are quite blocked. There was some discoloration of surrounding tissue probably due to the blocking and to feeding-punctures. For some unknown reason, only the adult female grasshoppers were found infected. It looks as if fully-formed adult mites emerged from the eggs. The occurrence of another tracheal mite is very interesting. More cases will probably be found.

Thyroid Feeding of Silkworms.—Two Japanese investigators have succeeded in feeding silkworms (*Bombyx mori*) with thyroid, a kind of experiment which has hitherto yielded no result with insects. They sprinkled mulberry leaves with a commercial preparation of thyroid gland in ratios of $\frac{1}{50}$ to $\frac{1}{100}$ of the weight. The silkworms ate the leaves, but not with their usual gusto. There was no hint of the acceleration of development that usually follows thyroid feeding. Indeed the more thyroid extract the silkworms got the slower was the development. The moths were smaller than usual, but they laid nearly as many eggs as usual, or in some cases decidedly more than the controls did. So far the results of the experiments were not what might have been expected. But the investigators went on to compare silkworms reared from the eggs of the thyroid-fed parents with the offspring of the controls. Without receiving any thyroid food the offspring of the former, smaller when hatched, shot ahead of the controls till the beginning of the fifth stage, when they became abruptly smaller and formed smaller cocoons and developed into smaller moths. Yet they made

more silk, and the moths laid more eggs. It follows that there must have been a small amount of thyroid principle in the eggs, the effect of which was manifested in the size, the silk-gland and the reproductive system. The moral is: Wait for the next generation before drawing a conclusion.

FARM IMPLEMENTS IN SCOTLAND.

HISTORICAL NOTES.

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IV.—1850-1900.

Steam Tillage.—From the middle of last century up till the 'eighties, the opinion was widely held that the application of steam power was on the point of working a complete revolution in farming, a revolution comparable to that which it had already brought about in transport and in industry. Long before this time, of course, stationary steam engines had begun to be used for driving threshing mills and other barn machinery, and when Cobbett rode through the Lothians in 1832 he already found all the large farms equipped with threshers, most of which were driven by steam. But it was to steam tillage that men looked to establish the new epoch. Among the many prospective benefits were counted "the deepening of the staple of the soil," its more thorough preparation for the crop, and the saving of at least one third in tillage costs. Substantially heavier crops were to be grown, fallows were to be done away with, and on the lighter soils the necessity for "resting" land (in temporary leys) was to be obviated. The steam engine was speedy, it was tireless, and was independent of weather conditions; moreover it could be maintained without eating up, as the horse did, a substantial part of the product of its own labours. "Years may yet elapse," says Sir John Forbes[1] in 1866, "before the consummation of the process, but the 'jocund team' is doomed. Changes must be made, fields squared, companies formed, implements improved, but the silent march of events will most surely bring the new power into general use." It is perhaps still a safe prediction that the horse will ultimately be displaced by some form of mechanical power, but its "expectation of life" has improved rather than declined since the days of our grandfathers.

The first patent for a steam ploughing apparatus was taken out by Major Pratt in 1810. His system seems to have embodied the same principle as others which later achieved success, but there is no record of its having been put in practice. In 1832 a patent was obtained by Heathcote, and four years later a trial of his system took place on Red Moss in Lancashire and created a good deal of stir. Heathcote's engine was of the catterpillar type. On each side it was supported on an endless band which revolved on a pair of large drums. The bands were seven and a half feet broad, and

[1] *Farmers' Magazine*, vol. xxv.

the drums twenty-six feet apart, giving a total bearing area of 390 square feet. Although the weight of the engine carrying its full six tons of coal, was no less than thirty tons, its "buoyancy would have enabled it to traverse much softer soil than flow moss." On either side of the engine at a distance of 220 yards were placed two "auxiliary carriages" or anchored pulleys, and two ploughs were worked simultaneously, one on either hand. Since wire ropes had not then been invented, a flat band of iron $2\frac{1}{8}$ inches broad and $\frac{1}{16}$ inch thick was used to draw the ploughs to and fro between the engine and the auxiliary carriages. The ploughs themselves were of the single-furrow one-way type, with two sets of irons set tail to tail, and a double set of stilts at either end, it having been found necessary to employ two men to guide. The total staff required was nine men and a boy. The Highland Society appointed a deputation to attend the trial, who reported that the results were satisfactory in so far that the moss, which was too wet to have carried horses, was successfully ploughed; but what object it was hoped to gain by ploughing land in such condition is not clear. The reclamation of Red Moss was not proceeded with, and no attempt was made to adapt the apparatus for ploughing ordinary land. In 1837 another trial was carried out at Lochar Moss near Dumfries, in connection with the Show of the Highland Society, and seems to have passed off successfully; but when, after the trial, the engine was left standing on the moss overnight, its "buoyancy" proved unequal to the occasion and it disappeared completely, never to be recovered.[1]

In 1836 the Highland Society offered a premium of £500 for the first successful application of steam to the cultivation of the soil, but no award was made, and in 1843 the offer was withdrawn.

Next in point of time was a steam tackle introduced by Lord Willoughby d'Eresby in 1851. Two engines were used in this case, and a two-furrow plough was drawn backwards and forwards between them by means of a chain. It is noteworthy that the necessity for the use of two engines was held to be a serious disadvantage, yet after years of effort devoted to devising single-engine systems, makers found that under most circumstances the balance of advantage lay with the older plan. Among other names associated with pioneer work in steam tillage are those of Messrs. Fiskin of Newcastle and the Marquess of Tweeddale, but the chief credit for the development of the system on commercial lines belongs to the firm of Fowler of Leeds, who exhibited their first set of tackle in 1854, and to whom most of the subsequent improvements have been due.

It scarcely requires to be said that the measure of success attained with steam tillage fell far short of the earlier anticipations. It is true that in the first enthusiasm for the new power it was often injudiciously used, land being ploughed wet, under the impression that this would do no harm, and too deep, under the impression that deep ploughing must necessarily be beneficial. It is true also that soon after steam tillage became a practical possibility a severe agricultural depression set in, and much of the old heavy arable, on which steam would have found its greatest

[1] History of the Highland Society.

usefulness, went out of cultivation altogether. But quite apart from these considerations, it is clear that in a country of moderately small farms and of complex farming systems, steam was never destined to play more than a minor role.

Diggers and Roto-Tillers.—For the most part the practical application of steam was accomplished by the use, in modified form, of the old standard implements—ploughs, grubbers, harrows, and rollers. But quite early in the course of these developments the doubt was expressed whether these old methods should not be abandoned in favour of some "more economical and philosophical manner" of preparing the soil. The plough, it was argued, was at the best only an imperfect substitute for the spade or fork. It performed indeed one of the functions of these tools, that of inverting the soil, but it did so at the cost of compressing both the furrow-slice and the subsoil. Moreover it left the pulverisation of the soil to be accomplished by other operations, in the course of which a considerable part of the work of the plough might be undone. With all the possibilities of steam power at command it must be possible to devise something far more efficient, a machine that would "comminute, aerate and invert the soil" in one operation, and leave a tilth "as fine as a new mole heap."[1]

Following up this line of thought an almost countless number of inventors have applied themselves to the designing of mechanical diggers and rotary tillers in various forms.[2]

Among the first that attracted notice was a kind of rotary steam plough invented by James Usher of Edinburgh in 1849. A portable steam engine, mounted on broad wheels, carried behind it a horizontal transverse shaft, which could be raised or lowered at pleasure and which was driven by means of gear wheels from the engine. On this shaft were fixed four or more discs or plates, each carrying three sets of plough-irons (coulters, shares and mould-boards) of a curved pattern, the soles forming segments of a circle. The shaft revolved in the same direction as the wheels and at considerably greater speed, so that the earth was dug up in small portions and thrown rather violently backwards, with a certain amount of side spin imparted by the mould-board. The rear wheels of the engine were likewise driven by gearing, and by this means the rate of progress over the ground was regulated, but it was found that the action of the ploughs was alone sufficient to propel the machine. The engine was of 10 horse power, and the whole apparatus weighed 6½ tons. It travelled at three miles an hour, and was capable of tilling 7 acres a day at a cost, it was claimed, of *2s. 6d.* per acre. An improved model, weighing a ton less and with an engine of 14 horse power, was brought out in 1855, and a company "with ten pound shares and two dukes and various baronets among the subscribers" was formed to exploit the machine, "but unfortunately this ingenious invention has no more been heard of in the agricultural world."

In 1852 Bethell patented a roto-tiller in which the working parts consisted of prongs or tines, as in modern models. The tiller

[1] C. W. Hoskyns' "Chronicles of a Clay Farm," 4th edn., 1857.

[2] For a complete account of these up till 1859, see Clarke, *Journal of Royal A.S.E.*, vol. xx.

shaft was driven by steam, but the machine was drawn by horses. It dug to a depth of 9 inches and "did as much in one operation as two or three ploughings, besides scarifying, harrowing, &c." Later Bethell adopted a steam locomotive, having endless rails upon its wheels in order to prevent injury to the soil, and introduced other improvements, but after a few years his invention sank into oblivion.

Several other machines were patented in the fifties, and Clarke,[1] summing up the situation in 1859, said that "With so much evidence in its favour, and so much mechanical and agricultural intellect at work upon it, the revolving steam-digger has now every prospect of vanquishing all obstacles and entering upon a career of success." But it was not yet to be; all the machines, in common with the much later Darby Digger, were too heavy for the land to carry, too expensive to build, too cumbersome to handle and too liable to breakage by stones. Many of these objections have been overcome by the substitution of oil for steam and of steel spring tines for iron prongs. A fresh supply of "mechanical and agricultural intellect" is being applied to the problem, and it seems possible that the confident predictions of Clarke and Hoskyns may yet be justified and Stephen's "more economical and philosophical" mode of tillage may become a reality.

American Influences.—For the greater number of the notable agricultural inventions that were made up till the middle of the nineteenth century the credit belongs to Britain, and in no small share to Scotland. But from that time onwards North America began to play an increasingly important part, and in the last quarter of the century most of the novelties that attracted the notice of farmers were of American origin. With broad acres of rich prairie land to exploit and with the single disadvantage of scarce and expensive labour, it was to be expected that the Transatlantic farming community would concentrate a great deal of effort and skill on the devising of labour-saving appliances. 1879, remembered as perhaps the blackest year in the whole history of British farming, was marked by the introduction of the string binder, of which the essential part, the knotter, was invented in America by Appleby. This completely solved, at the one end, the labour problem of large-scale corn growing; there remained the more complex aspect of the question, that of effecting a material reduction in the wages cost of tillage.

Along this line perhaps the most interesting of the American achievements was a complete remodelling of the plough. It was reduced in weight; it was so modified as greatly to lessen the friction on the working parts, and so as to enable it to turn a much wider if shallower furrow-slice. With an appropriate team of light and fast horses it could be driven at a greatly increased pace and could turn over in a day a far greater area of land than the old European types. Not only so, but the furrow-slice, instead of being slowly and gradually turned over through a carefully calculated angle and left almost unbroken, was violently and completely inverted and thoroughly shattered in the process, so

[1] *Supra.*

that the subsequent work of preparing land for the drill was greatly lightened.

The main principle involved in these changes--the replacement of the old, long and gradually twisted mould-board by a short bluff concave breast—was not in itself new, having been used in certain German types of plough from quite early times. But mouldboards of the old materials—wrought and cast iron—failed to scour or to run clean in the new shape, and it was only after the introduction of chilled steel that the full application of the idea became possible. The early "Yankee" ploughs that were brought to this country in the eighties proved but a partial success. For clay land they were too light, and their short stilts provided insufficient leverage to enable the ploughman to keep them in the ground. Also when they were used for autumn work in the wetter districts their finely-broken furrow-slices ran together again into a solid mass before the spring. But with the necessary modifications and under suitable conditions "digger" ploughs have proved their usefulness, and have become a part of the standard farm equipment of many districts.

In the nineties there came from Canada our modern types of spring-tined implements, both cultivators and harrows. Here again the weight was lessened, penetration of the soil being secured by the sickle shape of the tines, while their "give" to obstacles and their vibratory motion led to a material lessening of draft. The original Canadian cultivators proved insufficiently strong for the type of work that the British farmer was accustomed to demand, and even now, with all the improvements that have since been made, there come times when they are cast aside in favour of the old grubber and drag. But on medium and light soils, under ordinary circumstances, they can do all that is necessary, and with a considerable saving of horse flesh. The disc harrow is another American invention that has found a more limited sphere of usefulness in this country.

Of the implements designed for dealing with particular crops some, like the potato digger, are home inventions, while others, like the hay loader, originated in America. The various crops have yielded in very different degrees to mechanical treatment. Hay for example can be cut, tedded, collected, loaded and stacked with the help of machinery at every stage. At the other extreme stands the root crop which, in spite of half a century's effort to devise machinery for its cultivation and harvest, is still painfully singled with the hand hoe, and raised at the cost of many numbed fingers and aching backs.

Milking Machines.—The first attempts at mechanical milking were made before 1850, but it was not until the eighties and nineties that anything approaching success was achieved. In the earlier machines several distinct principles were tried; drainage (by means of milk tubes inserted into the teats) was, as might have been expected, entirely unsuccessful; pressure machines, in which the teat was gripped and squeezed by pads, were found to be far too cumbersome and complicated; but the suction principle, first used in America towards 1880, seemed to hold out more hope of success.

The first notable contribution of Scotland was a machine patented by Murchland of Kilmarnock in 1889, which acted on the

principle of sustained suction, and was installed on several West of Scotland farms in the early nineties. This was followed by the "Thistle" machine, invented by Dr. Shiels of Glasgow in 1895 and embodying the new principle of intermittent suction or pulsation, which was ultimately proved to be superior.

In 1897 the Highland Society conducted a trial of milking machines for which these two were the only entries, and after a thorough test the Committee reported that in their opinion the Murchland machine was a practical success, and unanimously awarded it the prize of £50 which the Society had offered.[1] On the other hand they reported that the Thistle machine failed in certain respects to fulfil the conditions that had been laid down, particularly in that the milk drawn by it did not keep satisfactorily. This was due to the very great length of tubing through which the milk had to pass, and to the large volume of air which was drawn through with it.

In spite of the favourable report on the Murchland machine, it was not altogether successful in practice, as the continued suction was found to cause disorders of the udder. The "Thistle" Company exhausted all its capital in experimental work and went out of business, but one of its directors, Mr. Kennedy, in conjunction with an engineer named Lawrence, continued to work at the problem and succeeded in making important improvements, which they embodied in the Lawrence-Kennedy machine. This was officially tested along with the Murchland machine by the Royal Agricultural Society in 1900, but neither received an award. However, a further improved model of the Lawrence-Kennedy and a machine brought out by Wallace of Castle Douglas in 1907 ultimately became the first standard types. Although the credit for the invention of the milking machine belongs chiefly to Scotland, the benefit has accrued mainly to the newer dairying countries like New Zealand, where the labour problem is more acute.

Looking back through the past two centuries one cannot but be struck by the immense increase in the number and complexity of the farmer's tools. The change is not altogether clear gain, for it necessarily involves a great increase in capital outlay and an increasing burden of maintenance charges. Many of the improvements have been of little actual benefit to the farmer, who has often been in a happier position than he is to-day, and few have brought material rewards to their authors. But in the mass they have immensely increased the production of food in relation to the human effort expended on its production, and have rendered possible a vast improvement in the general standard of life.

Much remains to be done. There are general problems like the application of electricity to field operations, and there are special problems like that of mechanical potato gatherers and root singlers, which, however hopeless of solution they may appear, will doubtless yield to the "mechanical and agricultural intellect" of the future generations.

[1] *Transactions of the Highland Society*, 1898.

AGRICULTURAL RESEARCH IN THE BRITISH EMPIRE.

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I. SOUTH AFRICAN VETERINARY RESEARCH STATION, ONDERSTEPOORT.

A GOOD deal of interest is being taken at present in the possibility of agricultural development within the Empire. Great Britain is the world's largest importer of agricultural products. The annual value of the imports is about £484,000,000. Of this amount only £177,000,000 comes from our own colonies and dependencies. But there are parts of the British Empire which, if developed, could supply a much larger proportion of the agricultural products required by this country. The Empire contains about two-fifths of the world's cattle, and the yield of beef and milk from these could be greatly increased. It has also great tracts of potentially fertile land which are only partially developed. Indeed the greater part of the world suitable for European settlement and still awaiting development is within the Empire. The visit of Mr. Ormsby-Gore, the Under-Secretary for the Colonies, to East and West Africa has helped to direct attention to the possibility of increased production in these parts with resulting increased trade with this country, and there are other areas not only in Africa, but in other continents, where the prospects of agricultural development are good.

It is worth while noting that increased production in the colonies and dependencies is of almost as much value to this country as it is to them. An increase in the export to Britain of tropical products used for feeding-stuffs would give a greater and cheaper supply of the concentrates required for increased milk, beef, bacon and egg production at home, and the development of the stock industry in any part of the Empire will increase the demand for breeding stock from this country. On account of the large imports of foodstuffs from foreign countries, there is room for increased imports from within the Empire, without necessarily increasing seriously competition for the British farmer.

In most cases the successful development of agriculture in the colonies and dependencies is dependent upon the solution of problems continually being met with in the course of development. In many cases investigations have necessarily been confined to urgent problems which have a local economic bearing, and whose interest is therefore chiefly local. In the older colonies, however, work of world-wide interest is being done. Indeed some of the problems being studied are merely different aspects of the same general problems engaging the attention of research workers at home. The establishment of the Civil Research Committee of the Cabinet and the Empire Marketing Board provides facilities for the investigation of these problems on a scale hitherto impossible, and in the next few years there is likely to be a great increase in the volume of research work carried out in the various colonies

Central buildings of the Onderstepoort Veterinary Research Station

and dependencies and a closer co-operation between the work at home and at colonial institutions.

It is just possible that in the past we have directed attention too exclusively East and West across the North Sea and Atlantic Ocean, and that in the future the research activities of our own dominions and colonies will warrant a greater amount of attention on the part of those engaged in agricultural research in this country. It is intended that a short series of articles dealing with research activities in various parts of the Empire will be published in this Journal. The present article gives an account of the Veterinary Research Institution in South Africa. Features of research activities of general interest in other colonies will be dealt with in subsequent articles.

The Veterinary Research Station of South Africa is situated about seven miles from Pretoria. It consists of a group of separate buildings. The illustration shows the central block which contains the offices and the library. The other buildings consist of laboratories, animal houses and subsidiary buildings. There is also housing for some of the staff of about 120 Europeans and 250 natives. The Institution forms a small township. It has its own post-office and its own railway station. The total capital cost to date has been in the neighbourhood of £250,000. This figure, however, is likely to be exceeded as certain further developments are contemplated.

The annual maintenance requires nearly £100,000. For 1925-6 the cost was £98,000. Roughly, half of this sum is for the payment of salaries and the other half for maintenance, viz.: apparatus, materials, experimental animals, feedingstuffs, native labour, &c. There is, however, a large revenue derived chiefly from the sale of vaccines. Last year this amounted to £28,000, so that the net annual cost of the Institution is only between £60,000 and £70,000.

Although the primary function of the Station is research in diseases of animals, it has been found expedient to extend the scope of its activities. In addition to investigating the causes of diseases, the Station manufactures on a large scale vaccines and anthelmintics for the prevention or cure of disease. In the year 1925-6 over seventeen million doses were issued.

Advisory work is carried out in connection with diseases and nutrition, and facilities have been provided for the necessary bacteriological, pathological or chemical examinations required for the diagnosis of disease. About fifty thousand pathological specimens, such as blood-smears, samples of tissues and stomach contents, are dealt with in the course of the year.

It was decided recently to take advantage of the excellent facilities which the Station offered for educational purposes; arrangements have been made for the education of veterinary students, and there are now full courses for men entering the veterinary profession.

This centralisation of veterinary activities at Onderstepoort has very real advantages. Advisory work carried out from a centre where there is a large staff of scientific workers engaged on research on the subjects on which advice is asked is likely to be of

maximum value. All the knowledge of the various experts of the Station can be brought to bear on the questions raised. On the other hand, the continual stream of questions from all parts of the Union of South Africa keeps the research workers in touch with the problems of immediate economic importance, and further, it gives them a great deal of valuable data which have been collected by those seeking advice. The enquirers have of necessity made a number of first-hand observations which they record when stating the problem they wish solved by the Station. Teaching carried out at such a centre is bound to be most stimulating. During their course students see and in many cases actually take part in the experimental work being carried on at the Station. They are thus in constant touch with men doing original research on the subjects being taught, and the diseases whose causes are being studied, or for which preventive or curative measures are being devised, are the very diseases which they themselves will be called upon to deal with after they graduate.

Most of the research work done at Onderstepoort has been on insect-borne and other infectious diseases which are not common in this country. The results of these investigations are therefore of more interest to tropical and sub-tropical countries than to Britain.

The investigations which have created most interest in this country are those carried out on Lamsiekte and Styfsiekte. As the results obtained in these investigations have a direct bearing on problems being studied in various parts of the Empire, including Britain itself, they warrant special mention.

Lamsiekte was studied for several years before the cause was discovered. The results of the earlier work, which was negative so far as the cause of this specific disease is concerned, has, however, been not only of scientific interest, but also of considerable practical value. It was thought at one time that lamsiekte might be a deficiency disease due to lack of vitamins. The testing of this hypothesis has shown that it is unlikely that a vitamin deficiency can be a serious factor in the nutrition of farm stock kept under practical conditions, which is the same conclusion as that reached from work done in this country.

It was finally discovered that the direct cause of lamsiekte is ptomaine poisoning brought about by an organism which flourishes in carcase debris. Cattle get infected with the organism through chewing the bones of carcases lying about on the veld. It was further discovered that the cause of the "pica" or depraved appetite which made cattle eat the rotten carcases was a hunger for phosphorus, and that if any digestible phosphorus-rich substance were administered to the cattle, the depraved appetite disappeared; the bones of the decayed carcases were no longer chewed, and the infection with the organism ceased.

It was further found that not only did the feeding of a substance rich in phosphorus, such as bone-meal or bran or an inorganic salt, prevent lamsiekte, but the animals receiving the additional phosphorus were in other respects more healthy. In young animals there was a marked increase in the rate of growth. Thus in one experiment, which ran from January 1922 until May

1923, the average rate of increase of two animals fed extra phosphorus was 434 lbs. compared with 150 lbs. for control animals.

In the case of milk cows it was found that increase in the phosphorus intake resulted in about a 40 per cent. increase in milk production. Further, the crop of calves was larger, and the calves were heavier and more vigorous at birth.

Chemical analyses of the soil and of the natural pastures of the areas in which lamsiekte occurs showed that both were markedly deficient in phosphorus, and that the extent of the deficiency could be correlated with the degree of malnutrition in the cattle.

Styfsiekte, a disease presenting some of the features of lamsiekte, has also been proved to be due to a mineral deficiency. It can be cured or prevented by feeding a mixture of bone meal and common salt. Whether this disease is due solely to a phosphorus deficiency, or whether, as appears probable, there is also a calcium deficiency, it is impossible at present to say, as the bone meal which prevents the disease supplies both calcium and phosphorus. This disease is under further investigation. An account of these investigations have been given by Theiler, Green and Du Toit (1924) (1).

It will be of interest to Scottish workers to note that Dr. Green, Sub-Director, Biochemical Section, who has taken a leading part in these investigations, is a graduate of Glasgow University, where he carried out research in nutrition in the Physiology Department. He was at one time on the staff of the West of Scotland College of Agriculture.

Dr. Du Toit, who will shortly succeed Sir Arnold Theiler as Director, has been invited to give a paper on the work of the Station at the British Association Meeting this summer at Oxford, where he will meet a number of the British research workers.

The South African work on phosphorus deficiency in pastures which has been so successful in its practical application is an important part of the general problem of the mineral contents of pastures. This general problem has been under investigation in this country for the past five or six years, and is still engaging the attention of workers at the Rowett Institute and at Cambridge. An account of this work which has been carried out by a committee consisting of Major Elliot, Under-Secretary for Scotland, Professor Wood, F.R S. of Cambridge, and the writer, has appeared in this Journal (2).

Work of a similar nature has also been done in other parts of the Empire where malnutrition suggestive of a mineral deficiency appeared in cattle. In one area in New Zealand there is a phosphorus deficiency; in another area there is an iron deficiency. Calcium or phosphorus deficiencies have been found in Australia and New Zealand, and iodine and calcium deficiencies have been found in areas in Canada. The research work on lamsiekte though undertaken by the Institution at Onderstepoort for the solution of a local problem, has thus yielded results which are of interest to those studying the nutritive value of natural pastures in several different parts of the world.

The rapid growth of this Veterinary Research Station which has been established and developed during the tenure of office

of the present director, is an indication that the work accomplished has been of economic value to agriculture in South Africa. The Station is a monument to the driving force and organising ability of Sir Arnold Theiler, who has had a free hand in its organisation and development. The South African Government, though not without a considerable amount of persuasion on the part of the Director, has been generous with funds. General Smuts, who was Prime Minister when the need for funds arose, saw the invaluable service which such an institution could render in the development of the live stock industry in South Africa, and gave the support and encouragement necessary for the continuous series of extensions and developments which took place. This support has been fully maintained by the present Government, whose leaders take a deep interest in the development of the Station and the work being done.

The reference which has been made to the South African work on the mineral content of pastures, and to work of a similar nature at other institutions, shows how the work of this Station can be correlated with that of other research centres throughout the Empire. There is little doubt that in the future there will be an increase in team work for the solution of agricultural problems common to different parts of the Empire, and that several different institutions will take part in this work simultaneously. In this co-operative research the Veterinary Research Institution at Onderstepoort is likely to take a prominent part, and to do work which will be of great value for the development of agriculture, not only in South Africa, but throughout the Empire.

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(1) Theiler, Green, and Du Toit, *Journal of the Department of Agriculture*, May 1924.

(2) Elliot, Wood, and Orr, *Scottish Journal of Agriculture*, vol. viii, No. 4, October 1925.

FARM PESTS—BIRDS.[1]

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Future Investigations regarding the Rook.—Although it suffers from the disadvantage that it covers many types of agricultural land, the investigation made some years ago in Germany by Hollrung[2] ought to be mentioned, for in scope it far exceeded any examination of the food of rooks made in this country, and by so much may be expected to give a more accurate picture of the average nature of the food. Hollrung examined the food content of the enormous total of 4,030 rooks, spread over a period of eleven

[1] Articles in this series, dealing with Mammal Pests, commenced in the JOURNAL in July 1912. The first article on Bird Pests appeared in January 1924.

[2] M. Hollrung: "Beiträge zur Bewertung der Saatkrähe auf Grund von 11jährigen Magenuntersuchengen" in *Landw. Jahrb.*, Berlin, vol. 35, 1906, pp. 579-620.

years. His results in so far as they affect the farmer may be summarised as follows :—

Grain destroyed by 4030 Rooks.

	Germinated.	*Not germinated.*
Wheat...	15,578	...
Barley...	10,465	247
Oats	12,787	...
Maize	987	40
Buck wheat	1,777	...
Rye	...	358
Totals ...	41,594	645
	42,239	

Harmful Insects destroyed by 4030 Rooks.

Cockchafers	2,222
Cockchafer grubs	2,264
Other Chafer beetles	1,717
Click beetles	2,307
„ larvæ (wire worms)	1,589
Weevils	14,710
Caterpillars	9,126
Crane-fly larvæ (leather jackets)	3,411
Chrysomelid beetles	2,113
Cassid (Tortoise) beetles	2,062
Burying beetles (Silphidæ)...	984
Bibio fly larvæ	406
Corn ground beetle	86
Total ...	42,997

Even if we admit that the destruction of silphid beetles should rather be reckoned against than for the rook, we have a total of insects equivalent to the total of grains of corn. But this does not indicate an economic equality; Hollrung himself calculates that the chafer beetles destroyed by the 4,030 rooks, would themselves have been responsible for the destruction of half a million feet of cereals, a stupendous total in which single grains are lost sight of.

Yet in spite of the labour which has already been spent upon this and other investigations of the food of the rook, it would appear that still further research is needed to clarify the position, for still agriculturists are divided into two opposing camps, one in favour of, one violently against the bird. The discussion in the preceding pages, however, should have made plain that the old diffuse type of investigation must be abandoned in favour of more precise methods. In the first place it is useless to endeavour to legislate for the *average* rook on *average* agricultural land. Since the proportions of the beneficial and harmful ingredients in its food vary according to the food available, that is, according to the type of cultivation over a large area, it is essential that the rook inhabitants of different types of agricultural ground, classified

according to some such scheme as that indicated at the close of the preceding article, should be treated more or less as unit groups, each to be studied by itself. Instead of presenting one great unsolvable problem the rook presents a series of minor problems, each capable of an approximate solution.

In the second place, collecting must be carried out so as to afford a fair sample of the rook's activities throughout the year in a particular unit area. No just notion of the morality of a population can be gained by selecting the criminals for examination. In the third place, since the monthly totals of rooks killed and examined cannot be arranged precisely to correspond with the varying number of rooks in the area month by month, a simple statistical adjustment of the results must be made to give each month its due weight in the final result. And, finally, no mere numerical or volumetric result can in itself be conclusive. Waste grain must be ruled out, allowances made for harmless activities hitherto added up against the rook, and a rational interpretation must assess the relative values of grain and of injurious insects, each of which may destroy many grains.

The Protection of Crops from Rooks.—In several types of agricultural areas the rook would appear to be on the whole a benefactor, and if, in such areas, it could be prevented from damaging corn crops without being destroyed, the farmer would reap additional benefit. Various devices have been employed to that end, usually with a success that at best is but temporary, though fortunately the period during which a crop is vulnerable is usually a short one, and temporary success may meet the needs of the case.

Scarecrows.—Scaring methods are almost innumerable in their diversity. Perhaps the best is the farm boy, armed with a pair of wooden clappers, who patrols the threatened area Next in popularity, if not in efficiency, is the human effigy, the old hat and coat, whose limp protection is too often detected by birds so wary. Dead crows hung throughout a field are more effective in their guardianship, and many mechanical devices have been used with occasional success, such as the suspension of pieces of tin or bottles which glitter as they swing, and windmills which work a noise-producing apparatus.

Deterrents.—The rook does not scratch the soil as farmyard fowls do, nor is its beak a very suitable implement for seeking out buried grains, therefore it is likely that the greater part of the corn it gathers from the seed-bed is picked up on the surface. Applying this probability, farmers have successfully withdrawn the attentions of rooks from the seed-corn and sprouting grain by scattering on the fields grain softened by water. The sacrifice of a small quantity of grain in this way during the short period when the crop is subject to damage is well repaid by the escape of the sown corn.

In America successful attempts have been made to protect seed by coating the grains with various substances which render them unpalatable to crows of various species.[1]

[1] See E. R. Kalmbach, "The Crow in its Relation to Agriculture," U.S. Dept. of Agriculture, *Farmers' Bulletin*, 1102, 1920.

One of the best of such deterrents has been found to be coal tar. The grain is heated by means of warm water and then drained. Coal tar, in about the proportion of a tablespoonful to half a bushel of seed-grain is added, and the grain stirred until an even coating of tar results. The seed must then be dried by being spread on a dry surface, or by the application of fine dry soil or ashes. Thereafter it may be used in the ordinary way in a sowing machine. The thin tar coating so applied in no way prevents the germination of the seed, but if dry weather follows the sowing germination may be retarded for a few days. On the other hand, in periods of normal rainfall, the retardation of germination is slight.

Red lead is also used, the grain being first coated thinly with size to cause the adhesion of the red lead powder, which is dusted on.

Experiments have been carried out with many other substances which impart an unpleasant taste or odour, such as paraffin oil, crude carbolic acid, fish oil, spirits of camphor,[1] turpentine emulsion and an aniline oil solution;[2] but it was found that when the strength of the deleterious substance was sufficient to protect the corn it seriously affected the germination of the grain.

The chief objection to the coal tar or red lead methods of protection, which otherwise are efficient, is that, under present conditions, the time and labour involved in the preparation of the seed would add materially to the cost of laying down the crop.

Destruction of Rooks.—While it may be that in some types of agricultural areas these mild methods of crop protection will be sufficient, it is certain that more drastic means must be adopted in other areas.

An attempt to shoot crows on the attacked crop is more useful as a deterrent than as a method of slaughter, for the rook is a wary bird which fights shy of the gun. In France, however, much is made of an owl decoy placed within easy range of a concealed gunner, and Kalmbach, in the *Farmers' Bulletin* already referred to, reports that in the United States of America "the use of crow decoys and crow calls has been resorted to with such success in attracting the birds within gunshot that these articles are now placed on sale by extensive dealers in sporting goods."

In Scotland the organised "crow-shoot" is the established method of keeping down the numbers of rooks. The shoot, shared by as many guns as may be convenient, takes place at the rookery either after the eggs are laid or just after the young are able to take short flights about the tops of the trees. In the latter case the endeavour is to shoot as many rooks as may be deemed desirable, in the former a subsidiary object is to keep the parent birds off the eggs until the eggs become chilled, so that they may fail to hatch even if subsequent attempts at incubation are made.

Shooting may also be resorted to where a winter roost, in which rooks congregate from outlying nesting-rookeries, has

[1] T. H. Scheffer, Kansas State Agr. Coll. Exp. Sta., Circular 1, 1909.

[2] B. M. Duggar and M. M. M'Cool, Cornell Univ. Agr. Sta., Circular 6, 1909.

become a nuisance. Here noise is one of the chief weapons of attack, and consequently black powder in the cartridges is preferable to smokeless. Relays of gunners keep up a commotion in the wood for several nights in succession, in order that the disturbed birds may be induced to forsake their headquarters. Where guns may not be used, roman candles or crackers thrown into the tree tops have proved successful.

Finally, without the use of the gun, rookeries, particularly in low pine-woods, may be "put down." Mr. Walter Stewart gives an account of such a method.[1] "During the months of March to June inclusive no gun should be allowed near these coniferous rookeries which it is intended to put down. They should be subjected to the minimum of molestation until the last week of April, when with the help of a sectional rod of some light material, such as bamboo or aluminium, every nest should be methodically put down, and the young killed in a humane and expeditious manner. Should nest-building again be proceeded with, the nests should again be put down after an interval of six weeks. The above remedy may sound somewhat callous, but really it is only the stamping out of an abnormal, predatory tendency, which is developing amongst some members of a very useful species of bird."

Birds and the Garden.

The garden, if not an essential part of the farm, is so universal an adjunct of the farm-house, and those extended gardens, the fruit farms, play so important a part in the cultivation of favoured districts, that a short section may well be devoted to the commoner bird pests of this highly specialised branch of agriculture.

On the whole, I think it may be said that birds are more useful in the garden than the reverse. Here, even more than in the fields, are illustrated the effects of high cultivation, and that implies a greater departure from the original balance of life which prevailed in the wild country before man set about his improvements. A curious sidelight is thrown upon the influence exerted by grades of cultivation upon animal life by Hensen's observations on earthworms. In primæval soil earthworms are not common, but Hensen's careful examinations revealed that the highly cultivated soil of a garden yielded 53,767 earthworms an acre, and he believed that the less intense cultivation of the corn-field would yield only about half that enormous number. The increase is a measure of the influence of cultivation in providing additional food supplies.

Extend the notion of the influence of such increased food supplies to the creatures which feed directly upon the plants grown in the garden, and we probe the secret of the prevalence and multitude of the insect pests of cultivation. Now and again, in this region and that, insect pests threaten the very existence of the cultivation which has brought them into being, and it can hardly be doubted that in every region insects must have reduced the higher cultivation to the verge of failure had it not been for the part taken by insectivorous birds in the warfare against insect pests.

[1] *Scottish Naturalist*, 1923, p. 146.

But the cultivation which has so enormously increased the opportunities of the insect, and through them the numbers of insects and of the birds which prey upon insects, has also in other ways directly increased the opportunities of the birds themselves. Where a few wild rasps grew in the thickets, there are now fields of cultivated rasps; where a few crab apples and wild cherries flourished, there are now great orchards in which abundance of luscious fruit tempts the hungry or thirsty bird. That is a necessary sequel to the achievements of cultivation.

No section of the garden is free from the danger of attack by birds. The vegetable garden suffers, shrubberies may be destroyed, blossoms are pinched from the flower borders, but perhaps the fruit garden bears the brunt of the attack. It generally happens that the same species of bird is concerned in several of these nefarious activities, so that a hard and fast horticultural grouping of the birds is impossible, and it seems most convenient to discuss the misdeeds of each species separately.

Finches and the Garden.—*The House Sparrow.*—In the vegetable garden the house sparrow does sporadic damage throughout the year, but it is at its worst during spring, when the young begin to feed on their own account. Then any succulent greens are taken, especially in dry weather when they serve for both food and drink. Lettuces and peas are nibbled as they appear above ground, and young and old sparrows play havoc with the juicy flower buds of the latter. The same desire for succulent food leads, in the flower garden, to the destruction particularly of the yellow blooms of crocuses, primroses and cowslips, and in the fruit garden to much damage to fruit buds.

Gooseberries suffer most heavily, for the young flowers, as they open, are squeezed for their nectar and as a consequence, the fruit fails to set. Extensive damage is sometimes done in this way. C. H. Hooper[1] (p. 76) quotes a letter from a Gloucestershire fruit-farmer as follows:—"I have known sparrows to destroy two acres of gooseberry bushes (in one year) by taking out 90 per cent. of the buds. The result was that the few buds that were left went to wood, and in a few years the bushes had scarcely a bud upon any of the lower branches." He adds in fairness:—"On the other hand, I have seen sparrows destroy thousands of caterpillars of the winter moths." The sparrow does not confine its attention, however, to gooseberries. It pecks also the blossoms of apples, cherries, pears and plums, and of the grown fruit it takes occasional gooseberries; strawberries, cherries and currants.

In spite of this formidable list of crimes, it must be said that where the stomach contents of sparrows have been carefully examined, the analysis shows that by their destruction of injurious insects and weed-seeds, sparrows in fruit-growing districts do more good than harm.

The Chaffinch.—In the garden the chaffinch plays a part very similar to that of the sparrow, though its occurrence in smaller numbers in most gardens minimises the damage. In the vegetable garden the leaves of sprouting crops—turnip, cabbage and lettuce

[1] "Fruit-growing and Bird Protection." *Journ. Royal Soc. Arts*, vol. 55, 1906, pp. 72-88.

—are chattered. In the fruit garden, fruit buds of many kinds are nibbled, and blossoms are pinched and destroyed for the sweet drop of nectar they contain. As regards the former activity, F. Smith[1] writes, "the chaffinch is not considered a bad bird, but he is a great disbudder of fruit, gooseberries, currants and plums, especially after a frost, when these birds will be found in twos and threes all over the plantation eating the buds." Indeed the birds may perform their work so effectively that whole branches are left throughout the summer bare of leaf or fruit. Blossoms as well as buds are destroyed, most often those of gooseberries, currants, cherries and plums. Apart from this spring attack, the chaffinch is, however, looked upon rather as a help in the garden than an enemy.

The Greenfinch or Green Lintie.—The activities of this bird much resemble those of the chaffinch. They have been summarised in a preceding article (1925, p. 296). In the kitchen garden it takes sprouting crops, and in spring it destroys leaf and fruit buds. In addition, according to Hooper (p. 80), "it is terribly destructive in pulling hop flowers to pieces to get at the seeds, and comes in large flocks and litters the ground with the flower bracts of the hop." To this drastic advocacy of temperance may be added the benefits done by the greenfinch in destroying the seeds of many weeds and the insects upon which it feeds its young.

The Bullfinch.—It would be difficult to pass an equally favourable verdict upon the bullfinch, the handsome colouring of which picks it out among the lesser birds. The expansive brick-red underparts and blue-grey back of the cock bird, surmounted by glossy black head and chin, make a striking combination, less often seen than might be, because of the shyness of the bird. In summer it keeps mostly to the woods, where in April the slight nest is built, well hidden in a tree or bush. During that or the succeeding month the first brooding of eggs, four to six in number, with red and purple streaks or spots upon a greenish-blue ground colour, is laid. From autumn to spring the woods are forsaken and the bullfinch leads a roving life, which brings it in frequent conflict with the gardener. During this period the numbers of British bullfinches are supplemented by the immigration, though on a small scale, of a continental form of the same species, distinguished by its larger size and rather more resplendent colouring.

The bullfinch is not generally distributed in Scotland, but in places it is locally common, and its distribution in England is similarly restricted, although there the bird is much more frequently met with. It is from southern Britain, therefore, that most of the accusations against the bullfinch come, although complaints specifying damage to fruit trees by bullfinches in Inverness-shire have been made to the Board of Agriculture for Scotland.

Hooper (*loc. cit.*, p. 77) gives a very serious picture of the activities of the bullfinch. "Where numerous in a fruit growing district it seems that for self protection they must be killed, as the damage they do to the buds is a serious matter, and often they

[1] "The Fruit Grower and the Birds," a paper read to the Maidstone Farmers' Club, 1906, pp. 1-10.

wantonly destroy the buds without even eating them. They commence soon after Christmas, when the first spell of frost has sweetened and swollen the buds, and continue eating them until the buds expand into leaves. The worst time is the beginning of March.

"The bullfinch feeds on buds, especially of plants that bear fruit, such as plums, damsons, cherries, gooseberries, currants, apples and pears, it shows a special liking for greengage, black diamond, purple gage and early Rivers plums, which it will first attack in an orchard. It shows a preference for certain varieties of gooseberries, and amongst apples the buds of 'Councillor' are favourites. . . . Mr. F Smith, of Loddington, says that bullfinches rove about in families of five or six through the winter A family will come into a fruit tree, and stay there till they have destroyed

THE BRITISH BULLFINCH[1]

all the buds, both fruit and wood They usually begin with 'May Duke' cherries in the early autumn, and keep on with plums, gooseberries, currants and medlars, ending in late spring with black currants and apples"

For some six months in the year, autumn till spring, the food is largely made up of buds, and to these cultivated fruit trees make a substantial contribution, though the buds of "wild" trees such as hawthorn, blackthorn, rowan, bird-cherry, beech, sycamore and larch are also eaten. During the remaining months bullfinches live upon the seeds of chickweed, thistle, ragwort, dandelion, nettle, dock, plantain, charlock and the like. Insect food seems seldom to be taken, but Dr Collinge's examinations[2] showed

[1] From Saunders' *Manual of British Birds*, by courtesy of Messrs. Gurney & Jackson, Edinburgh and London

[2] "Food of some British Wild Birds," 1913, p 42.

that the young were fed largely on insects, contrary to the opinion that seed softened by their parents formed their main sustenance.

In face of such statements, typical of the evidence of fruit-growers, it is clear that the bullfinch may not be tolerated on fruit farms. In most cases it is likely to be destroyed by shooting or trapping, but more than one grower has found that lime-wash spraying of bushes preserves the buds from the birds' attacks.

The Hawfinch.—Larger than the other finches and remarkable because of the dumpy appearance given by its large head with enormous lead-coloured bill and its short tail, the hawfinch is clad in shades of reddish brown with sparse touches of grey and white. It is a rare bird in Scotland, but in recent years has become a regular resident in parts of the lowlands, and it has occasionally nested north of the Forth. In England it is much more common, especially in the southern counties, but even there it is local in its distribution.

On this account the damage it does is not extensive, but although it is seldom observed at work, on account of its shyness, traces of its presence are left in many a garden near its haunts. It is particularly fond of green peas, and may strip open rows of pods for their contents. It sometimes pecks ripe fruit, such as pears and apples, to get at the seeds, and it is said to eat damsons and nuts.

Otherwise it feeds upon seeds of trees and on haws, cherries, holly and yew berries, all of which it takes for the sake of the seed, which it splits in its strong bill. Caterpillars and insects are also eaten, sometimes in considerable quantities. Much of its activity is harmless, some is beneficial, and there are few places where the hawfinch is sufficiently common to demand drastic treatment.

WART DISEASE OF THE POTATO: INFECTION TESTS.

THE Board of Agriculture for Scotland have had under consideration the advisability of developing a practical method of testing the reaction of the potato to wart disease without having recourse to field tests. Experiments have been in progress throughout the winter of 1925-1926 with this end in view.

During the past four years there have been submitted annually to the Board 120 varieties for critical field test, while the number of varieties submitted for the purpose of a preliminary single tuber test has averaged 800 per annum. Single tuber tests, which are at present carried out in the field, are undertaken to enable breeders of seedling potatoes to discard as early as possible those individuals which are susceptible to wart disease in large batches of selections.

Methods of infecting varieties in the laboratory have been indicated by various writers, but none of these meets the necessities of the problem, as presented to the Board, of testing any number of varieties up to, say, 2000 annually, without employing special apparatus or making elaborate arrangements for the supervision of laboratory tests.

The object of the experiments was, therefore, to devise a rule-of-thumb method which would involve the minimum of apparatus and laboratory space and which would enable tests to be conducted with the least possible demands on the time of the staff.

After several unsatisfactory experiments a simple method has been found which is capable of application to an unlimited number of varieties.

The method is in essence a modification of that employed by Miss Glynne. The tubers which are the subjects of test are placed with their rose ends buried in moist sphagnum moss in petri jars (four tubers to a jar)—placed uncovered on laboratory benches, the day temperature of the laboratory ranging from 10° C. to 20° C. Tubers carrying fresh developing wart are swilled in the smallest quantity of tepid tap water necessary to wash them well. The washings of wart thus obtained are applied to each individual tuber by means of a teaspoon. Sufficient is applied each day to make the bed of sphagnum very wet. Continuous excess of free water in the petri jars is to be avoided, as it rapidly induces rot in the tubers under test, but occasional drying out of the petri jars does not influence the result of the tests. Ready identification of tubers can be obtained by marks, e.g with Chinese ink, on the exposed heel end.

The preliminary experiments which indicated this method as a satisfactory one were applied, during March 1926, to single tubers representing eight susceptible varieties, namely, Epicure, Ninetyfold, Duke of York, British Queen, King Edward VII, Northern Star, Field Marshal and Arran Chief. At the end of 28 days all eight tubers had developed wart disease, the excrescences after that period varying in size from that of a pin head to that of a bean. The jars were watered when convenient—generally once daily—but allowed to dry during week ends.

A further experiment was carried out in April and May to verify these results. 57 varieties, including 12 immune varieties, in lots of four tubers of each variety, were submitted to this test. Some of the jars containing the tubers were placed on a laboratory bench over a radiator where they were subjected to a temperature of from 14° C. to 24° C. The other section of the experiment was set on a laboratory table which received no direct heat. The general temperature of the room varied during the progress of the test from 10° C. to 20° C. The tuber material had sprouted considerably before being utilised and the tubers were soft. The long sprouts were knocked off before the tubers were subjected to the test. The presence of sprouts whether broken or unbroken was found to be conducive to the incidence of rot, which was encouraged by the presence of too much free water and by too high a temperature. In that section of the experiment which was kept at a moderate temperature the tubers did not rot so readily; where rotting occurred excess of moisture was clearly responsible. The whole of the representatives of 10 susceptible varieties and of two immune varieties rotted at an early stage of the experiment. However, wart disease was found on all the unrotted representatives of the remaining 35 susceptible varieties, while in no instance was wart noted on the remaining 10 immune

varieties. The shortest period of infection was 18 days, but the time taken for the disease to develop was from 28 to 35 days.

Subsequent tests in May and June on a further series of varieties have confirmed the efficacy of the method. In this series new (imported) King Edward VII. developed wart disease in thirty days; this indicates the possibility of applying the test to tubers shortly after their being harvested.

A parallel experiment to the above described preliminary test involving a modification of the method of Spieckermann and Kotthof also yielded useful results. Here the sphagnum was impregnated with powdered rotted wart which had been subjected to over 10 degrees of frost in November 1925. It was found necessary for successful infection, however, that the test should be carried out in the dark. Of the eight varieties in this test seven were infected in 28 days; the other, Northern Star, did not sprout. This method, however, was rejected in favour of the "infection by washings" method, because the tuber sprouts developed in darkness to such an extent as to make handling difficult.

A third series of preliminary tests, in which fresh growing wart *in situ* was placed over four other tubers and watered with tap water daily, was unsatisfactory.

All three types of infection were applied simultaneously to a group of four varieties (three controls and one unknown) in open conditions. The four tubers were found to be infected after 28 days.

The "infection by washings" method has the advantage of entire simplicity, and, in view of the fact that it can be repeated four or five times on the same variety or series of varieties between November and April of any year, should prove to be a more trustworthy index of susceptibility than that provided by field tests, which are unreliable in dry seasons.

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Sugar Beet Growing in Scotland.

IN the issue for July 1925 of this Journal there appeared a short account of some experiences recently obtained in the growing of sugar beet in the north of Scotland. Because of the increasing importance of the crop in Great Britain, and of the larger acreage grown in Scotland last year, some enquiries have been made by the three Scottish Colleges of Agriculture with a view, so far as

may be practicable, to secure authentic information regarding the treatment of the crop on various farms and the results obtained.

Area of the North of Scotland College of Agriculture.—In the northern area, by far the most gratifying returns were obtained in the county of Moray. There the crop was sown generally on a deep loam inclined often to be heavy. The seeding was at the rate of 12 to 14 lb. an acre in shallow drills varying from 21 to 28 inches wide. The highest yield was from a crop grown in 24 inch drills. On some farms part of the crop was sown on the flat with rows 18 inches apart, but, in general, higher yields were got from drilled crops, and there was less difficulty in cultivation. From the information obtained it would appear that in a good many cases no very definite system of manuring was adopted. Various mixtures such as "potato manure" and "turnip manure" or mixtures of familiar ingredients compounded by the farmer himself were used. The general experience with regard to manuring is that (1) it is preferable to apply dung to the preceding crop, or at any rate not later than early winter; (2) the land should not be deficient in lime; (3) a good phosphatic dressing is 5 cwt. of basic slag in winter, or 2½ cwt. of slag at that time and 2½ cwt. of superphosphates in spring; (4) on light soils a full dressing of 5 or 6 cwt. of kainit or from 1 to 2 cwt. of muriate of potash is desirable; smaller dressings suffice for heavier land; and (5) 1 cwt. of sulphate of ammonia should be applied before drilling, and 1 cwt. of nitrate of soda after the crop has brairded.

Moray.—The crop developed favourably after sowing and, although June was a very dry month, the nature of the soil was such as to retain the moisture well until rain came in July. The highest yield per acre was 12 tons 13 cwt. of clean washed beet of 19·2 per cent. sugar content, realising £33, 13*s*. 8*d*. an acre. Other recorded returns were on the average substantially more than 10 tons per acre, while the sugar content ranged from 16·8 to 19 per cent.

Nairn.—In this county the practice was similar to that followed in Moray; but as the soil is on the whole lighter, the crop suffered from the drought in June. The yield of washed beet was therefore much lighter than that of Moray, varying from 6½ to 9 tons an acre. The sugar content was, on the average, nearly 18 per cent., and in no recorded case was it below 17·5 per cent.

Inverness.—A crop was grown experimentally on a highly cultivated home farm in this county. Although the soil was a rich clay loam the yield amounted to only 8 tons per acre, with a sugar content of 16·35 per cent. The crop while growing appeared to be a heavy one and it was well cultivated and kept very clean. At harvest, however, it was found that a large proportion of roots was deformed and "fangy." This condition was probably due to the fact that farmyard manure had been applied to the land (and ploughed in shallow) in spring.

Sutherland.—On one farm seed was sown on 10th June in drills 28 inches wide, on a field of fairly deep clay loam. A heavy dressing of farmyard manure was ploughed in during autumn, and in the spring a well-balanced mixture of artificials was applied. The yield was 9 tons 2½ cwts., with a sugar content of 15 per

cent. Earlier sowing would doubtless have given superior results. When the crop was lifted in January it was noteworthy that it had suffered no damage from the severe frosts prevalent in December.

Area of the Edinburgh and East of Scotland College of Agriculture. — In the eastern area observatious were taken of the methods adopted and results obtained in the Lothians, Fife, Perthshire and Roxburghshire.

Mid and East Lothian. — The recorded results from crops grown on fertile soils varying from light to heavy loam show a yield of washed beet ranging from 6 to 12 tons per acre. The percentage of sugar content ranged from 15½ to 17½. Seed was sown either on the flat or in drills varying from 22 to 25 inches wide. In all cases the land was well manured. One grower expects to secure better results this year by sowing in 21 inch instead of 25 inch drills, while another has decided to sow this year's crop on the flat instead of, as last year, in the ordinary turnip drill. With regard to time of sowing, it appears to be the experience that April is too early and that better results will be obtained by seeding about the second week of May.

Fife.—On two farms in one district where the soil is a light loam the returns showed respectively yields of 7 tons (16 per cent. sugar content) and 8½ tons (16·5 per cent. sugar content) of clean washed beet. In the former case the seed was sown in 27 inch drills, in the latter case it was put down on the flat so late as the last week of June and, contrary to accepted practice, farmyard manure was applied a week before sowing. Both these crops are said to have met all expenses incurred in respect of them. On two other farms of medium loam, one crop was sown on the flat and yielded 11⅘ tons of 17·5 per cent. sugar content; the other, which was sown so late as 12th June in 27 inch drills, yielded 8¼ tons of 17·4 per cent. sugar content. Both of these crops are stated by the growers to have given a satisfactory profit.

In another district a crop sown on the flat in heavy loam produced 7½ tons of 15 per cent. sugar content and is stated to have repaid costs. Another crop sown on the flat in medium loam gave 9 tons of 17·8 per cent. sugar content and a sufficient profit to the farmer.

Observations were taken of the results at six centres in other districts. The soils varied from light to medium loam. The seed was sown either on the flat or in 24 inch drills. Potato and turnip manures were used with an autumn dressing of dung. The average return of clean washed beet was 9½ tons of a sugar content of 16·9 per cent., the highest yield being at the rate of 11¼ tons per acre. On the average the prices received for the crops exceeded the costs of growing and of delivery.

Perthshire.—On one farm the crop was grown on a free loam with sandy subsoil, the method of cultivation being similar to that in use for turnips. The yield amounted to 9 tons of 15·5 per cent. sugar content per acre. It was stated that the financial return did not compare well with that usually derived from potatoes.

On two farms in the south-east of the county yields per acre of clean washed beet of respectively 11 tons 13 cwts. (16·9 per cent.

sugar content) and 10 tons 17 cwts. (18 per cent. sugar content) were obtained. In each case the seed was sown about 15th May on good medium loam in drills 24 inches wide. The land was manured in accordance with accepted principles. The financial returns were considered to be not unsatisfactory.

Roxburghshire.—Records were made of the results obtained on four farms. Seed was sown during the first fortnight of May in drills varying from 25 to 28 inches wide. On a clay soil the crop was a failure, yielding only 2¾ tons. On deep medium clay loams a return of from 8 to 9 tons of clean washed beet with a sugar content of from 14·3 to 15 per cent. was obtained. The best crop (10 tons 12 cwts. with sugar content of 15·2 per cent.) was produced from a fairly deep sandy loam.

Area of the West of Scotland Agricultural College.—Observations were taken of crops grown in Argyllshire and in Ayrshire.

Argyll.—While the summer of 1925 was favourable to the growth of sugar beet, the wet, inclement weather of May and the beginning of June not only checked severely the brairding plants, but also caused considerable delay to operations of tillage. Farm work was thus thrown considerably in arrear with detrimental effects which were evident later in the season. In many cases, however, the crop was grown on wholly unsuitable soils, as, for example, stiff clay and thin gravel. Large quantities of the roots were therefore small and badly shaped and the average yield per acre was light. The sugar content of the roots, however, was promising, the average of 29 consignments being 16·83.

It was not practicable to obtain accurate data regarding the areas of the crop and the method of cultivation followed in most of the farms. The following notes, however, relate to one acre of crop which was successfully grown.

Nature of Soil.—Peaty or mossy with fair admixture of earth and in clean condition.

Cultivation.—Land ploughed in October; harrowed once in spring before ploughing into 24 inch drills.

Manuring.—Sulphate of ammonia 3 cwts., superphosphates 3 cwt., basic slag 3 cwt, potash salts (30 per cent.) 4 cwt., all applied in the drill.

Seeding.—15 lbs. seed per acre; first seeding on 15th April, second on 1st May; the first seeding produced the stronger plants.

Thinning.—In one operation on 1st June. (Plants from the second seeding were backward compared with the others.)

Yield.—Harvested in November and December. Net weight of washed beet was 12 tons, 15 cwts. per acre. The sugar content was 18·1 per cent. for the first and 17·9 per cent. for the second consignment.

With regard to financial results, it would appear from data furnished by two successful growers that the net profit in a single acre grown by each was respectively £7, 7*s.* 6*d.* and £5, 13*s.* This experience cannot, however, be said to have been general. The crop is a new one and demands the acquirement of the necessary amount of knowledge and skill in its management. A suitable

soil, proper manurial treatment and timely cultivation are essential. Because of failures in these respects, and also because of the unfavourable nature of the past two seasons, the crop may not have had a fair trial in this county. That this is recognised by farmers is evidenced by the fact that the area under the crop this year will probably be substantially greater than last year.

Ayrshire.—For a variety of reasons the crop in different parts of this county proved a failure. While the weather of April and May was unfavourable, the land chosen for the crop was often unsuitable either in respect of the nature of the soil or of its condition. The most promising feature of the crop was its sugar content, this averaging fully 16½ per cent. for the county.

Gooseberry Rust.

THIS rust on the gooseberry, *Puccinia Pringsheimiana*, is characterised by vivid orange red spots, which occur on the leaves, berries and stem.

The rust has an alternate stage on certain common sedges, where it causes yellowish spots on the leaves. These spots are followed by darker brownish spots. On the gooseberry the spots are striking, the fungus forming small yellow cups on a red and swollen area. The cups can just be seen with the naked eye, but more easily with a magnifying glass. The distortion and swelling of the orange areas is marked and sometimes, on the stem, the blister may be an inch in length.

If the disease is severe, the berries may be entirely covered with the bright orange disease. In a mild case it usually only affects the leaves, but the bright spots on these catch the eye at once. It may be severe enough to destroy the crop, and, even if not so severe, the spots very much disfigure the fruit and lessen both amount and value.

The fungus requires both hosts to complete its life history. An epidemic of this rust occurred suddenly in an upland Highland village on all the gooseberry bushes in the cottage gardens. On enquiry no swamp or ditch with sedges could be found. It was, however, found that a byre had recently been thatched with material brought up from the lowland. On examination this was found to be sedges covered with the brown resting (*teleutospore*) stage of the fungus. This was the source of the sudden attack.

The disease cannot be entirely prevented unless the affected sedges are found and destroyed, but can usually be kept in check by picking off and burning the diseased parts of the gooseberry bushes.

THE following article has been contributed by Mr. Dan. W. Steuart, B.Sc. (Agric.).

Scandinavian Feeding Reports.

I. In 1923 a new class of pig work was started, not dealing with ordinary farm pigs as previously, but with selected animals. A considerable number of pigs, two males and two females from each brood sow, are delivered at the Astorp experiment station from the

FIG. 1.—Gooseberry twig with Rust (cluster cup stage) showing on berry and leaf.

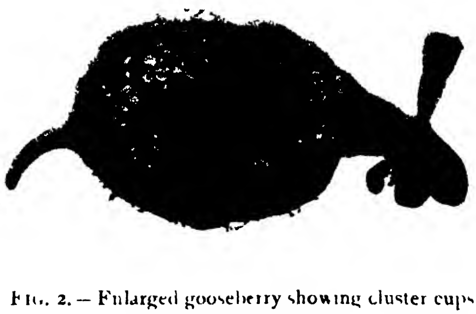

FIG. 2.—Enlarged gooseberry showing cluster cups on surface of fruit.

leading breeding stations in the country, at eight to ten weeks old. These are put on uniform food and slaughtered at an average weight of 200 to 210 lbs. The preliminary results were shown in Swedish Report, No 266 (1924). During 1924 the work proceeded on the same lines: 53 approved experimental groups, comprising 203 animals, were slaughtered and judged. In Report No. 289 (1925) Professor Hansson summarised the results. The chief object of the experiments is to compare the productive qualities of the improved Swedish farm breed and the Swedish Yorkshires, and also to compare the leading breeding stocks one with another, for rapidity of growth, gain in weight for food consumed, shape, quality of the meat, fruitfulness of sows, &c. The results as a whole show a considerable improvement over those previously obtained with ordinary farm pigs (see this JOURNAL, January 1924, p. 83). They show a quicker rate of growth and a smaller consumption of food per 1 lb. of gain. The ordinary farm pigs (1908 to 1922) put on 1·2 lbs. of live weight per day and each 1 lb. required 4·15 fodder units The selected pigs (1924) put on daily 1·4 lbs. and needed 3·51 units per 1 lb. of gain.

II. In Swedish Report 296 (1925) Professor Hansson emphasises the fact that the amount of production fodder which cows require is dependent on the quality of the milk they produce. Thus 3 fodder units will produce 10 lbs. of milk with only 2·75 per cent. of fat, while it requires 4 units per 10 lbs. of milk when the fat percentage is 4·5. The amount of protein varies also with the quality of the milk. Feeding standards are only for general guidance. If fodder prices are low and dairy produce prices are high then the ration should be increased. When dairy produce is selling badly in relation to the cost of food then the fodder should be cut down to some extent.

In an article (*Svenska Mejeritidningen*, 1925), Professor Hansson gives the following scheme for group feeding a herd of Ayrshires; average weight 1,056 lbs., and average fat in milk 4 per cent.:—

	GROUP.			
	I.	II.	III.	IV.
Average milk yield lbs.	4	20	33	46
Mixed hay—lbs.	8·8	8·8	11·0	11·0
Oat straw „	8·8	8·8	6·6	6·6
Swedes „	33·0	26·4	35·2	44·0
Mangels „	...	28·6	35·2	44·0
Concentrates „	1·5	3·7	6·8	8·6
Fodder units	11·0	15·3	20·4	24·2

The concentrates mixture consisted of two parts of ground oats to one part each of ground nut cake, cotton cake and palm kernel cake. (*Note.*—The broken figures look a little ridiculous, so we have to explain that for example 8·8 lbs. appeared in the original as 4 kilograms.)

III. In "Landmannen, Tidskrift för Landtman," 1925, Professor

Hansson discusses the mineral requirements of domestic animals, and how they are to be supplied. American workers had shown that cows in full milk were losing minerals from their bodies to the milk, and that with ordinary feeding their only chance to make up for this was during their low yielding or dry period. Dr. Hasselbalch, a Danish physiologist, has been experimenting since 1921 on dairy cows by giving them mineral supplements and has obtained positive results. An increase of 28 lbs. of butter fat per cow in a 180 day period is recorded for 1923-24, when each cow got daily 1¾ ozs. of a mixture consisting chiefly of precipitated chalk, phosphate of lime and common salt. In other years he got just as good results with his Jerseys when sodium phosphate was used along with a little lucerne hay, which is rich in lime. Dr. Hasselbalch has come to the conclusion from his experiments that it is principally by supplementing the mineral supplies of low milking and dry cows that we will be able to affect the cows' yields during the following lactation period.

Reviews.

Lime in Agriculture. A Handbook for Practical Farmers, Students and Others, by F. E. Corrie, B.Sc. (Chapman & Hall, 3*s.* 6*d.*).—Considerable attention has been directed in recent years to the need for the increased use of lime in agriculture if the highest return is to be obtained from the soil. Mr. Corrie's book appears therefore at an opportune time, and the attention of the agricultural public can be directed profitably to the useful resumé which he gives of recent investigations on this subject.

In the first section he deals with the use of lime in plant nutrition, giving a clear account of the functions of lime in the soil and of the bad effects which are generally found in soils deficient in lime. The losses of lime from the soil, the use of lime in improving the tilth of the soil and in combating diseases, such as finger and toe, are adequately dealt with. Reference is also made to the various tests which have been devised to show if a soil is in need of lime, and to estimate in a rough way the amount of lime such a soil requires to make it more fertile. The directions given, as the author points out, are very general, and it is doubtful if a farmer without previous knowledge of the subject could make much use of them. The various sources of limestone, quicklime, and by-products containing carbonate of lime are described in detail.

The second section of the book deals with animal nutrition, and especially with the functions of the mineral matter of feeding stuffs. The amount of calcium required daily by different classes of farm animals is detailed, and means are suggested by which the deficiencies in mineral matter of various typical rations can be made good. There is a good and up-to-date summary of recent experimental work on the subject.

The book concludes with an appendix giving some typical analyses of soils and of various forms of ground lime and quicklime.

Tables are also given showing the lime and phosphoric acid content of a wide range of feeding stuffs and farm crops.

It is perhaps too soon to expect in a book of this kind any reference to the most recent work on base exchange and its bearing on soil acidity; this work promises to put the difficult problem of soil acidity on a more scientific basis, and to clear up some of the inconsistencies between acidity and the need for lime which we have been unable to explain satisfactorily in the past.

While clearly written, Mr. Corrie's book is so closely packed with information that the farmer who has had no scientific training will find it possibly rather hard reading. To the young farmer who has had the advantage of a course at an Agricultural College or Farm Institute, or who has attended a course of lectures by a County Lecturer in Agriculture, the book can be recommended and should prove useful.

A Pure Milk Supply. By A. Cunningham and T. Gibson, Edinburgh and East of Scotland College of Agriculture. New Series, No. 1.—In recent times the milk supply has received considerable attention both by the consuming public and by milk producers. The community is becoming increasingly more stringent in its regulations concerning the purity of the milk which it uses, and it is now necessary for dairy farmers in their own interests to become familiar with methods by which satisfactory milk may be produced. The agricultural colleges are endeavouring to assist farmers to fulfil their legal obligations, and a bulletin with the above title has recently been published by the Edinburgh College with this end in view.

The producer of pure milk aims at excluding bacteria as far as possible from his product. He also tries to prevent the growth of germs which find their way into his milk. The bulletin gives a few elementary facts corcerning the nature and occurrence of bacteria which require to be understood by those who wish to control these organisms successfully.

The authors bring forward a number of arguments in favour of the contention that it would be advantageous to the dairy industry to produce pure milk. The present low consumption of milk is partly due to the condition of the supply. The medical profession recognises the food value of cow's milk and also the desirability of increasing the consumption, but doctors feel that they are not justified in advocating an increased use of milk of the present standard of purity. The medical profession cannot be expected to recommend a food which is liable to contain dangerous disease germs. An improvement in the sanitary quality of the milk supply would also tend to an increased use of milk quite apart from the recommendation of the medical profession. A considerable loss from souring—a change which is brought about by bacteria—takes place under present conditions after milk has been delivered to the consumer. This is one factor which deters the public from using larger quantities of milk. That there is room for an increased use of milk in this country is shown by the fact that the consumption is only $\frac{1}{4}$ to $\frac{1}{8}$ of a pint per head per day, while only about 50 per cent. of the milk and milk products consumed are produced in the United Kingdom,

the remainder being imported from abroad. If the consumption of milk per head of the population could be doubled the increase in value of the product would amount to over £30,000,000.

While it is recognised that eradication of tuberculosis from the milk supply will be difficult and costly, the advantages which will accrue to the trade should not be lost sight of. It is well known that the yield of milk from tuberculous cows is low. Eradication of bovine tuberculosis would undoubtedly increase the productiveness of the dairy stock of the country. If the average increase per cow per annum is taken as 100 gallons (a figure based on the evidence available) the saving to the trade would amount to £13,500,000 annually.

The production of clean milk would also benefit the dairy industry by preventing loss of milk from souring during transit and distribution. This loss could be entirely eliminated if milk were produced and handled under sanitary conditions. At the present time about half of the milk supply is pasteurised at considerable cost in order to prevent it from souring; yet competent authorities estimate souring losses at 1 to 2 per cent. of the total supply.

A section of the Bulletin dealing with milk-borne human diseases brings together for the benefit of milk producers some of the evidence that the present milk supply is by no means satisfactory from the point of view of public health. It is pointed out that tuberculosis is the most important disease conveyed by milk. Probably 40 to 50 per cent. of all cows in this country are infected with tuberculosis. Animals suffering from so called "open" tuberculosis are constantly spreading the germs, and are particularly dangerous when the disease occurs in the udder. Other diseases which are more rarely conveyed by milk are septic sore throat, typhoid fever, scarlet fever, diphtheria and infantile diarrhœa.

Methods which may be adopted for preventing the spread of diseases through milk are discussed. For the elimination of tuberculosis the scheme which seems to be most practicable under present conditions is that advocated by Bang in Denmark. This method is based on the fact that less than 1 per cent. of the calves produced by tuberculous cows are infected. If calves are isolated from their mothers at birth they may easily be raised free from the disease. Some of the results which have been achieved by this method are quoted.

In a section dealing with the prevention of contamination during milking an effort has been made to distinguish between the serious sources of contamination and those which are normally of minor importance. It is stated that during the operation of milking the most important sources from which undesirable germs are introduced into milk are the cow, the milker and the milk pails. Methods by which contamination from these sources may be prevented are discussed in detail. Bacteria also enter milk from the interior of the cow's udder and from the air, and undesirable types may be introduced by flies. The authors lay great emphasis on the value of proper methods intelligently carried out, and they state that experiments have shown that byre construction has little influence on the bacterial content of milk. Provided that ventilation and lighting are adequate for the health of the cows, the only important

features of byre construction are the length and width of the standings and the size of the gutter.

The cleaning and sterilisation of dairy utensils are fully described and a discussion is given of the effect of straining, cooling, and methods of distribution on the bacterial content of milk.

Copies of this bulletin may be obtained free of charge by anyone interested on application to the Secretary of the College

Notes from Craibstone.

Effect of Time of Cutting Hay.—During the past few years in connection with the experiments in the seeding of the grass land at Craibstone, close attention has been paid to the effect of the time of cutting the hay on the quantity and quality of the crop, and also on the quantity and quality of the subsequent pastures. As regards quantity of the hay, these observations have not supported the general belief that early cutting necessarily leads to a loss of weight. Indeed, so far as these observations have gone, the opposite is the case, although in many cases a difference of a fortnight or thereby in the cutting has not led to any great increase or decrease; very late cutting has invariably given a poorer yield. It is true that, where the seed mixture contains a certain proportion of late flowering red clover, there is a considerable increase in growth after the majority of the other plants composing the mixture have reached their maximum, but, in the making of the hay, owing to the greater degree of maturity of the other clovers and the grasses, there is such a loss of the finer leaves that this reduces very materially the weight of made hay as compared with hay cut earlier, when the plants are not so fully matured, and when the leaves, therefore, in the course of making are not subjected to the same amount of loss. This loss in the finer leaves also accounts, to some extent, for the well-known fact that late cut hay is not of the same quality as the earlier cut. For two or three years analyses were made of early cut and late cut hay, and it was found that the earlier cut hay contained about 10 per cent. more leaf than the later cut. Chemical analyses made in these cases showed that the earlier cut was of much better feeding quality. From the point of view, therefore, of the quantity and quality of the hay, early cutting is undoubtedly of great advantage.

A still greater advantage, however, has been seen in the quality of the pasture in the second and third years, and particularly in the second year. It has been noted that the development of the white clover is very markedly superior where the hay has been cut early. Evidently it is extremely important that white clover if it is to develop well in the second year, should get a good start before the end of the first summer, and this it never seems to do unless the grass is cut early. Confirmation of this will readily be found in examining second year's grass where the first year has been pastured, as compared with a part where the hay was made, however early. It has been the general experience here that second year's pasture, from the point of view of white clover in it, is a year ahead where the hay has been cut early as compared with

where it was cut late. Another distinct advantage of early cutting is in the amount of aftermath that is got, a point of considerable importance in those districts where land is under grass for only one year, and where pasturage in the form of aftermath is therefore of particular value in the autumn. In this particular respect, although no actual grazing experiments have been carried out, it has frequently been found that the aftermath after early cutting was valued about the month of September at about twice that of aftermath where the hay was later in being cut.

Under the particular climatic conditions in the north-east of Scotland it is found that late-flowering red clover, although it undoubtedly adds considerably to the weight of the hay, and also to the value of the pasture in the second year as compared with the broad-leaved, has this great disadvantage, that it has not reached anything like full growth until the majority of the other plants in the hay are ready for cutting or should be cut. There is a great temptation, therefore, to delay the cutting in order to secure the full growth of the late-flowering red clover. For this reason many farmers might be inclined to discard late-flowering red clover from their mixtures, but this would be inadvisable, because, even although it has not reached full growth, this plant adds very materially to the weight of the hay, and is undoubtedly very much superior to the broad-leaved red in second and, in many cases, third year's pastures. It is found, too, that late-flowering red if allowed to reach anything like full growth has a very markedly depressing effect upon the development not only of the white clover, but also the natural grasses, cocksfoot and timothy. In all cases both broad-leaved and late-flowering should be included in mixtures for hay and pasture.

Damping-off.

THE term damping-off is commonly used to describe those diseases causing the death of very young seedlings in quantity, and is due to their cultivation under conditions that favour the development and attack of various parasitic fungi. Of these fungi the principal are :—

1. *Phytophthora cryptogea* and other Phytophthoras.
2. *Pythium de Baryanum* (long thought to be the chief cause).
3. *Rhizoctonia sp.*

When seedlings are attacked by such parasites the stem becomes discoloured and usually constricted at the soil level, then softens, and the plants topple over and die. It is in boxes and seed-beds that the disease appears, and there it can cause great destruction.

Environmental conditions increase the tendency to disease. Careful ventilation is required, having regard to the tender state of the seedlings. The best controlling factors of damping-off are sunlight and air.

Hosts.—All kinds of seedlings are liable to this trouble, more especially soft wooded plants raised in artificial heat under unnatural conditions. Petunias very often get a similar trouble when a little

beyond the seedling stage. Tomatoes suffer both as small seedlings and later on.

The disease is due to two factors: (*a*) certain cultural conditions predisposing towards infection, and (*b*) certain fungi which become parasitic under those cultural conditions. These fungi occur in soil and can live a long time in it. They can also be carried to the seedlings in infected water. They can lurk in crevices and cracks of wooden partitions or earthenware pots. Water as a means of carrying disease is frequently overlooked. When a plant house has been infected, any open tank in it is likely to be contaminated and should be thoroughly disinfected. Municipal water from a public supply or from a deep well is usually free of infection, but in an open tank can very quickly become infected with phytophthora.

Prevention.—In this case, as in many others, it is better to avoid trouble by not sowing too thickly and by allowing abundant air and sunshine, than to try to cure with chemicals. Otherwise some form of *soil sterilisation* is the best preventive. Sterilisation by *heat*, either dry, or with live steam is used extensively in America and by some tomato growers in this country. In the absence of facilities for using this method, one of the following three methods can easily be used:—

1. Formalin.
2. Cheshunt Compound.
3. Permanganate of Potash.

1. *Methods of Combating.*—Disinfection of seed beds, boxes, soil, &c., with formalin (this cannot be used at the time of sowing). A 1 in 50 solution of commercial formalin (roughly 2 tablespoonfuls formalin to 2 quarts) is applied to the bed or the soil, the soil being frequently turned, at the rate of two quarts of solution to the square foot. The soil is then covered to retain the fumes and allow the disinfectant to act thoroughly for 48 hours. After this 14 days must elapse, and it is often better if 21 days pass before the seed is sown.

2. *Cheshunt Compound for Damping-off (especially for Tomatoes).*

Copper Sulphate (finely powdered) 2 oz.
Ammonium Carbonate (finely powdered) 11 oz.

These chemicals must be very finely powdered and all lumps crushed out. They must be thoroughly mixed (dry) and stored before use for 24 hours or longer in a tightly corked stone or glass jar. The mixture must be kept from the air or it will lose its power.

To make up:—1 oz. of the mixture should be dissolved in a little hot water and cold water added to make it up to 2 gallons.

Plants suffering from damping-off in pots or boxes should be watered with this solution. It will not cure diseased plants, but will kill the fungi and save the rest. It will not injure living plants; it does not hurt the leaves even of young seedlings.

Seed-pans and seed boxes after planting should be watered with the solution to prevent damping-off, 1 pint solution to one seed box of (14×9×2 in.), the amount applied varying in proportion to the dimensions of the box. This mixture is specially

useful for phytophthoras on tomatoes. It is not as strong a disinfectant as formalin, but on the other hand can be used after the seeds are sown. It can also be used to wash boxes, boarding, edges of seed beds, &c., to keep away fungi. But as a preparatory wash for such things formalin is better.

Permanganate of Potash.—This is an old-fashioned remedy for damping-off, and it has the merit of being effective and easy to handle. Directly the disease appears in the smallest degree, all the beds and seed boxes should be watered with permanganate of potash in water (1 oz. to 4 gallons water) if the attack is slight, but if the fungi have got a good hold 1 oz. to 2 gallons may be required. All the beds, &c. should be watered with a fine rose.

Reinfection.—It must be remembered that the water supply of a greenhouse can become so much infected with disease organisms that it forms an important source of fungal trouble. The condition of sterilised soils favours the rapid spread of the parasite if they become reinfected. Therefore, if a pinch of infected soil or a drop of infected water comes in contact with sterilised soil, whatever the agent of sterilisation has been, the disease will spread very rapidly, and the soil may become a good deal more heavily infected than before treatment. It is for this reason that to be effective sterilisation must be so very thorough, and no unsterilised soil or sand or contaminated water should come near the prepared seed boxes or beds.

Agricultural Conditions.

THE weather during the first fortnight of March was generally unsettled and falls of snow occurred in many districts. The latter fortnight of the month was, however, favourable for spring cultivation, and good progress was made practically throughout the country. During the first half of April the weather was unusually dry and warm; rapid progress was made with spring work of every description and seeding was carried out under ideal conditions. The last fortnight, however, was wet and sunless with low temperatures, especially in the eastern districts, and in many areas outdoor work was practically suspended. The weather during May was favourable for turnip-sowing and other farm work, and live stock throve well. During the first two or three weeks low day temperatures and night frosts were general and growth was retarded, reports from districts widely separated stating that the early potato crop and the barley braird had been seriously affected. Conditions improved during the latter half of the month, however, and during the last ten days bright, mild weather prevailed and crops and pastures progressed rapidly.

The wheat crop made good average progress during the spring months and at the end of May was vigorous and healthy in most cases. In South-West Forfar and East Perth, however, many fields were still reported to be patchy. Rust is in evidence in some fields in Berwick, while in South-East Perth the crop has suffered to some extent from wire-worm. Taking the country as a whole, the area under wheat will probably show a slight diminution as compared with last year.

The sowing of barley was almost finished during April and was completed in May under favourable conditions. The crop is now well forward generally and promises well, the braird being vigorous and healthy and of good colour. The estimates of acreage sown indicate slight increases in Roxburgh, Selkirk and Dumfries, but in many districts it is considered probable that the area under the crop will prove to be somewhat smaller than last year.

The sowing of oats was practically finished at the beginning of May. Growth was checked to some extent by frosts during the first two weeks, but by the end of the month a strong thick braird was showing, and in most cases the crop is in a healthy condition. The reports from a few counties state that leather-jacket grubs are prevalent in some fields, but up to the present little damage to the plant has occurred. The area sown is estimated to be somewhat less in East Aberdeen, Orkney, South-East Lanark and North Ayr, while in Kincardine, North and East Perth, North-East Fife, Roxburgh, Selkirk, Stirling and Lewis slight increases are reported. From these estimates it would thus appear that the total area sown will prove to be somewhat similar to that of last year.

Beans are everywhere reported to be doing well, and, at the moment, there are good prospects for a very satisfactory crop. In many districts, particularly in the eastern counties, rye grass and clover seeds made little progress until the last week of May. The plants are now recovering from the set-back, however, and are, in most cases, reported to be fresh and healthy, with a good mixture of clover. In Kincardine and South-West Aberdeen it is anticipated that the yield of hay this season will be lighter than usual.

The planting of early varieties of potatoes was well forward at the end of March and they are now generally reported to be growing well. In South Ayr some varieties were almost ready for lifting at the end of May, while in Wigtown some lifting had actually been done. The planting of maincrops was in progress under very favourable conditions during the first half of April and was well advanced until interrupted by heavy rains; at the end of May the work was completed, or almost completed, in all districts. The area sown is estimated to be less than last year by about 20 per cent. in Moray and Banff, and by from 7 to 8 per cent. in North-East Aberdeen, South-West Fife, Clackmannan and Kinross, while from several districts smaller decreases are reported. Taking the country as a whole the acreage under the crop will probably be slightly less than in 1925. The sowing of turnips and swedes was well advanced at the end of May in most areas, while the sowing of yellow turnips was in progress and early sowings were showing a strong regular braird. The sowing of mangolds was completed in the southern counties at the beginning of June.

Sugar-beet has been sown over a considerably larger area than last year, especially in Fife, Kincardine and Perth, but in several districts the sowings are only on an experimental scale. Where sown early, the crop was showing above the ground at the end of May, and its appearance was then reported to be satisfactory.

The reports received at the beginning of June on the fruit crops were distinctly promising regarding some districts, including parts of Aberdeen, Kincardine, Fife and Forfar. In other parts of the

country, however, the frosty nights and cold, dry weather experienced during May caused considerable damage both to orchards and to small fruit, and the prospects were not so favourable. In South-East Lanark frost and strawberry blight have made the outlook very doubtful.

Grazing cattle are generally reported to have thriven fairly well. In some cases, owing to a shortage of winter keep, they were put on to their summer pastures rather earlier than usual, but grass soon became bare owing to cold, dry weather and stock did not make the usual progress; with more favourable weather towards the end of May, however, pastures recovered and cattle improved rapidly. Dairy cows have made average progress. The milk yield fell slightly at the beginning of May in some districts owing to insufficient pasture, but with improved conditions later in the month the yield increased and became practically normal. Sheep are generally reported to have thriven well, although in Kincardine and on the high grounds in Perth hill sheep are said to be in a rather backward condition.

Lambing was almost finished by the end of April and in May was completed in all districts. The crop of lambs on both arable and hill farms has on the whole been quite a good average, and in many cases the fall has been well above the normal, the most favourable reports being those from the western islands and some south-western districts. In Stirling and Kirkcudbright the death-rate among ewes has been above the normal, while in Kincardine the number of eild ewes has been unusually large; from North-East Aberdeen it is reported that casualties among ewes have been more numerous than usual, the deaths in most cases occurring immediately before lambing. Lambs generally are thriving well, although in North Ayr and Wigtown the death-rate from dysentery is reported to have been considerable.

The supply of regular labour was generally ample at the end of May, but in North Aberdeen, Kincardine and Skye experienced men were short of requirements, while in Renfrew, Dumbarton and Dumfries dairy workers, both male and female, were scarce. Casual labour was fairly plentiful, except in South-East Perth and Kirkcudbright.

Legal Decisions.

Assessment of Income Tax on Poultry Farmer.—The question as to whether poultry keeping can be regarded as husbandry or as a trade carried on for profit in relation to the Income Tax Acts was brought before the Court of Session in a Stated Case heard some time ago.

The facts of the case were as follows:—Frederick W. Lean and John Dickson, Castlehill, Symington, Lanarkshire, carried on business on a poultry farm consisting of thirty-three acres of land, all of which was in grass except half an acre upon which green crops were grown for consumption by the poultry. A permanent stock of about 1000 head of poultry was kept, and in addition 46 sheep were grazed on the land. Having been assessed under Schedule D of the Income Tax Act, 1918, they appealed to

the Income Tax Commissioners for the Upper Ward Division of Lanarkshire. The contentions put forth by them were that poultry farming was husbandry, that they occupied the lands in question for the purposes of husbandry only or mainly for these purposes, and that they were assessable to income tax under Schedule B on the basis of single rent of the subjects only, in terms of the Income Tax Act, 1918, Schedule B, as amended by Section 23 (1) of the Finance Act, 1922.

The Commissioners were of opinion that the term "husbandry" did not include the use of lands for the purpose of poultry farming, and that the assessment was properly made under Schedule D. The appeal was accordingly dismissed, but at the request of the Appellants, the Commissioners stated a case for the opinion of the Court of Session, the question of law being whether the Appellants were rightly assessed under Schedule D of the Income Tax Act, 1918.

The First Division of the Court answered the question of law in the negative, reversed the determination of the Commissioners, and held that in the circumstances the land was occupied for the purpose of husbandry, in respect that the fruits of the soil were used to a material extent for the sustenance of the poultry, and accordingly that the appellants were entitled to be assessed under Schedule B.

A similar question was decided recently by Mr. Justice Rowlatt in the English case of Jones (Inspector of Taxes) *v.* Nuttall. Mr. Nuttall was a poultry farmer who occupied three acres of land in grass on which he maintained about 350 head of poultry, and in addition kept two cows and a number of sheep. He had appealed to the Income Tax Commissioners at Preston against assessment under Schedule D. The Commissioners decided that Mr. Nuttall should be assessed under Schedule B, and the case was appealed by the Inspector of Taxes to the High Court.

Mr. Justice Rowlatt upheld the decision of the Preston Commissioners and dismissed the appeal with costs. His Lordship admitted that the case was a stronger one in favour of the Crown than Lean *v.* Inland Revenue, 1926, S.C. 15, and although he was not technically bound to follow that decision he followed it as full of sound law and good sense. It was well within the competence of the Commissioners to find that the poultry farmer in question was using land as land.

Landlord and Tenant.—Resumption of Holding under Order by the Scottish Land Court.—The question in this case was whether a statutory small tenant has a claim for compensation for disturbance at his waygoing from his holding where the holding has been resumed by the Landlord under an Order by the Scottish Land Court. It arose in a Statutory Arbitration under the Small Landholders (Scotland) Act, 1911, between Thomas Ballantyne, the outgoing tenant of the holding of Backshot, Forth, by Lanark, and Matthew Steele, his Landlord. The Landlord acquired the holding at Whitsunday 1924, and under an Order by the Scottish Land Court resumed possession thereof at Whitsunday 1925 for the purpose of personally residing thereon. Questions arose

between the parties as to payment of, *inter alia*, compensation for disturbance to the waygoing tenant, and Mr. Peter P. Campbell, 20 Rutland Square, Edinburgh, was appointed Arbiter by the Land Court.

It was argued for the tenant that an Order of the Land Court authorising resumption was equivalent to a notice to quit given by the Landlord as specified in Section 12 of the Agricultural Holdings (Scotland) Act, 1923, that said Section applied to every holding as defined by Section 49 (1) of the said Act, and that resumption by the Landlord was not given as one of the reasons under Section 12 (1) whereby the Landlord could escape payment of compensation. On behalf of the Landlord it was argued that the tenancy was not terminated by reason of a notice to quit given by the Landlord but by an Order of the Scottish Land Court, and that the tenant did not quit in consequence of such a notice, and further, that there is no provision for compensation to a statutory small tenant for disturbance of tenancy in the Small Landholders (Scotland) Act, 1911.

The Arbiter issued Proposed Findings in which he proposed to disallow the tenant's claim for disturbance on the ground that the Small Landholders Act provided for payment of compensation to a statutory small tenant in respect of "improvements" only, and that accordingly a claim for disturbance of tenancy was excluded.

At the request of the tenant a case was stated for the opinion of the Sheriff on the questions of law raised in the Arbitration. The Sheriff upheld the Arbiter's findings and an Appeal was taken by the tenant to the Court of Session, when the Interlocutor of the Sheriff was adhered to and the Appeal refused.

The Lord Justice Clerk, who gave the leading opinion, stated that he could find no trace in Section 32 (15) of the 1911 Act of an intention on the part of the legislature to award a statutory small holder, displaced under the circumstances of this case, compensation for disturbance, and that any compensation awarded under this subsection must be restricted to compensation in respect "of improvements on or in connection with" the land resumed. His Lordship also considered that the claim appeared to him to be excluded with equal directness under Section 12 (1) of the 1923 Act, as that Section, which provides for payment of compensation for disturbance, was prefaced by these words, "Where the tenancy of a holding terminates by reason of a notice to quit given by the landlord and in consequence of such notice the tenant quits the holding." In order to succeed the tenant would require to bring himself within the terms of that preface (which he had failed to do), there being no compensation provided by this Section for disturbance on termination of a tenancy by judicial process.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions. Full references to the original publications may be obtained on application to the Secretary, Board of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Sveriges Utsadesforening Tidskrift. *Argang XXXV.—Hafte* 5, 1925. 01102. *Svalofs Orionhafer C., by A. Akerman.* (Translation). "*A new and more productive line from Orion.*"— Orion oats which were put on the market in 1920 proved a great step forward with regard to the cultivation of black oats in Norland. Previous to marketing of Orion oats the yield of grain proved considerably in excess of its nearest rival, viz. Mesdag oats. Further, the kernel is larger, more compact and has a better appearance. Orion oat "C" had been mentioned as very promising in 1921 in the agriculturist O. Holmgren's Report of Experiments. In accordance with experiments then in hand results appear to show that this variety was quite equal to Orion oat "B" in seed production and superior in straw production, vigour and size of kernels.

Agriculturist Holgren has pointed out that the plant is richer in leafage than Orion "B." The straw as well as the foliage is comparatively green at the time when the kernel has attained its maturity. Although the foliage is comparatively abundant, the straw vigour is good, and in this respect Orion "C" decidedly supasses the quality of both Orion "B" and Mesdag. A few grades referring to straw vigour are shown in a table.

The panicles of Orion "C" like those of the old Orion are rather large and extended, but the panicle branches are not so limp. The kernel is larger, closer and more compact and has a groove.

A New Variety of Oats *Zavitz, C. A., Scientific Agriculture, Vol. V, No.* 8. *Ottawa*, 1925. —A new variety of oats has been produced at the Ontario Agricultural College, Guelph, and has been named O. A. C. No. 144. This new variety has surpassed the O. A. C. 72 by an average annual yield in the College tests over a period of seven years. It was included in co-operative experiments with other varieties on 80 Ontario farms in 1923 and on 310 in 1924. The seed is not yet available in large quantities.

The O. A. C. No. 144 is a tall, broad-leaved, stiff-strawed, late variety, with a spreading head and a long, slightly brownish-white grain, almost free from awn, and gives a heavy yield of both grain and straw.

Application for registration of the new variety has been made to the Canadian Seed Growers' Association.

Quality in Barley, *by H. M. Lancaster, Journal of the National Institute of Agricultural Botany, No.* 5, 1926.—Reference is made to the difficulty in defining quality. While there are many varieties of barley, those grown in the United Kingdom and used for malting are almost entirely two-rowed barleys. British barley varies in moisture content roughly between 13 per cent. and 21 per cent. These barleys can be successfully malted in the United Kingdom between 1st November and 1st March, and they are much improved as malting material by being artificially dried. Six-rowed barleys are also largely used for brewing, the chief sources of supply being California and Chili. They have a moisture content of between 10 per cent and 12 per cent. and never require sweating. Brewers generally like to use a proportion of malt made from them for two reasons—(1) that brightness in barley is a good thing for the beer; (2) that on account of being huskier than native barleys they help drainage in the mash tun. A malting barley should germinate to nearly 100 per cent.; it must not have been heated in the stack (i.e. mow-burnt) and it must produce malt which is "tender."

Maltsters when buying barley have to beware of two things—(*a*) barley which is "mow-burnt" and will not germinate, and (*b*) barley which will not modify completely but makes what is called "hard-ended" malt.

It seems that it is not so much the amount of starch as the sort of starch and the condition of the cellulose surrounding the starch of the grains that is important. Nitrogen content of barley may be to some extent the criterion of

the readiness with which barley can be malted. Other things being equal, barleys with a nitrogen content of between 1 per cent. and 1·5 per cent. are likelier to make tender malt than those with a nitrogen content of between 1·5 per cent. and 2 per cent. On the whole the writer prefers a ripe sun-dried barley to a ripe weathered barley, but would prefer a ripe weathered barley to an unripe sun-dried barley.

The Treatment of Seeds with Sulphate of Copper. *Rossetti Balanescu N. Viata Agricola, Year XVI, No.* 13. *Bucharest*, 1 *July* 1925.—With respect to the objections brought against the use of sulphate of copper in the treatment of seeds, to the effect that it decreases germinating power, and the tendency to replace it by other products with a mercurial base, the author criticises the various investigations carried out in Germany with mercurial preparations and other mixtures, and in France, Lithuania, Belgium and also in Roumania.

Comparing the very contradictory results of these experiments the author concludes that sulphate of copper used in solutions of correct strengths cannot have an injurious effect on unbroken healthy seeds.

The author describes the result of 32 years of his own experience and emphasizes the importance of the strength of the solution, which should vary with the kind of seed, whether it is hairy or smooth, with a hard shiny hull or soft and downy, with the embryo hidden or near the surface.

Statistical tables of experiments made in 1924 with autumn wheat show that the strength of the solution and the duration of immersion are the factors which determine the beneficial or injurious effect of sulphate of copper.

From the author's experiments it is shown:—(1) for autumn wheat the correct strength is from 1½ to 2 per cent. and the duration of immersion 3 minutes, in which case the solution is unable to penetrate into the seed even when slightly cracked.

(2) Only broken seeds fail to germinate, and the sulphate of copper used in solutions of strength and immersion corresponding to the nature of the seed stimulate germination, and have also a selective action on the seeds and eliminate those diseases which would affect the growth of the plant.

Variety Trials of Potatoes in England. *University of Leeds, Bulletin No.* 139. *Leeds*, 1925.—The Bulletin gives an account of a series of tests carried out from 1920 to 1924 on varieties of potatoes, in order to study the respective yields and immunity or susceptibility to Wart Disease (*Synchytrium endobiotica*) The chief results obtained are summarised in the following table:—

Average Yield of Ware Potatoes at Three Centres (in tons per acre).

Variety.		Osgodby.	Bridlington.	York.	Number of Years Grown.
Early—					
Dargill Early	(I)	9·7	7·287	5·2	4
Immune Ashleaf	(I)	7·45	7·262	9·825	3
Ally	(I)	12·85	10·65	11·45	3
Second Early—					
Great Scot	(I)	12·8	12·95	15·025	5
Arran Comrade	(I)	10·125	10·45	11·75	5
Main Crop—					
Tinwald Perfection	(I)	11·25	9·625	12·45	5
Kerr's Pink	(I)	14·05	11·787	13·85	5
Majestic	(I)	11·325	11·65	13·175	4
Bishop	(I)	9·3	9·337	10·087	3
Irish Chieftain...	(I)	9·0	6·937	7·725	2
Rhoderick Dhu	(I)	5·6	5·5	9·55	2
Crusader	(I)	6·3	6·7	5·575	2
King Edward	(S)	9·15	9·3	9·5	2
Arran Chief	(S)	9·15	8·3	11·1	2
Up-to-Date	(S)	12·95	7·7	11·3	2

Immune varieties (I); susceptible varieties (S).

Effect of Leaf-Roll Disease in Potatoes on the Composition of the Tuber and "Mother" Tuber, *by Wm. M'Lean, B.A., B.Sc., A.R.C.Sc.I., University College of North Wales, Bangor. Journal of Agricultural Science, Vol. XVI, Part 2, April* 1926.—The investigations were carried out with the object of ascertaining the difference, if any, in chemical composition between "healthy" and "leaf-roll" tubers. It had been found in 1923 that representative samples of healthy and leaf-roll tubers grown under the same conditions as regards soil, manuring, &c., lifted at the same time and analysed simultaneously, differed appreciably in their dry matter content.

An analysis of a representative sample of healthy and leaf-roll tubers of the variety Arran Comrade grown in 1923 showed that the precentage of dry matter in leaf-roll tubers was 4 per cent. below that of the healthy tubers, and that the percentage of nitrogen in the dry matter is appreciably higher in the leaf-roll than in that of the healthy tubers. The method of sampling is described, and a table shows the percentage of dry matter and nitrogen in the dry matter of healthy and leaf-roll tubers in 1923 and 1924 crops. One effect of leaf-roll disease in its secondary form is to reduce the percentage of dry matter in the resulting tubers. When there is any doubt as to the diagnosis of secondary leaf-roll by the usual symptoms, a determination of the dry matter in the "mother" tuber two or three months after planting would serve as a further diagnostic character.

Dry-Matter of Swedes, I., *by F. W. Sansome, B.Sc., Scottish Society for Research in Plant Breeding, Corstorphine, Midlothian. Journal of Agricultural Science, Vol. XVI., Part* 1, *January* 1926.—The writer describes several experiments carried out at the Scottish Plant Breeding Station with the object of finding a suitable method of sampling single "roots." It is suggested that a number of serious sources of error may arise in single root sampling, and that it is very difficult to obtain a truly representative sample of a root by the coring method. Different parts of the root were found to have different percentage dry matter contents. In the taking of the samples by coring the cores were taken from each root horizontally in a north-south direction approximately through the greatest diameter. The period at which samples should be taken is discussed. The ideal time for sampling is held to be between the period when the storage of nutritive material in the root has reached its maximum and the period when the stored nutritive material in the root commences to diminish in quantity—the "metabolic turning point." It is suggested that the difference in analyses between two varieties of roots might be due to the different times at which this condition occurs. In selecting roots on a basis of dry matter content, the size of the root is shown to be an important factor. An instance is cited showing that high dry matter content is a heritable characteristic. A well marked negative correlation was found between dry matter content and size of root.

The Bacterial Inoculation of Sugar Beet. *Nemec, A., Annales de la science agronomique, Year* 41, *No.* 4. *Paris*, 1924.—Experiments have been carried on for some time past in the adaptation of the bacteria contained in the root nodules of leguminous plants to non-leguminous plants, and it has been noted that the success of the experiments largely depends upon the bacteria of that part of the soil which is in immediate contact with the absorbent root hairs. These bacteria exert a favourable influence upon the penetration of the bacteria into the root hairs and hence upon the formation of the nodules.

The writer in his experiments used the Blunck method, which is based on the principle of successive adaptations of the bacteria of leguminous plants to the juices of the roots of the plants which have been the object of experiment and of the heightening of their effect by means of repeated transmissions through the same plant. Experiments made on a large scale on this method have always given good results, the increase in the yield varying from 5·6 to 17 per cent.. A negative result was shown only in cases where the yield of the non-inoculated control plots was at a maximum.

Hence bacterial inoculation provides a means of increasing the fertility of a soil up to the point of its maximum productivity.

The Evaluation of Hard Seed. *Brown, E. Report of the Fourth International Seed Testing Congress in Cambridge,* 1924. *London,* 1925.—The Association of Official Seed Analysts of North America have, in considera-

tion of the importance of establishing a uniform basis for labelling seeds, adopted the following rule:—"In reporting the germination of samples of leguminous seeds, a portion of which usually remains hard at the end of the test (i.e. does not take up water readily under normal conditions for germination), the actual percentage of germination should be reported, and also the percentage of seed remaining hard."

The need for further investigation on the adequate evaluation of hard seeds is now fully recognised by the American seed trade.

SOILS.

Effect of Soil Treatments upon the Draughts of Ploughs. *F. L. Dudley and M. M. Jones, Soil Science, XXI*, 40,277 (1926).—The experiments were carried out at the Missouri experiment station on plots which had been under different rotation and manurial treatments for 34 years.

The soil was a silt loam of a prairie type, and it was observed that presumably as a result of the different treatments, some of the plots had become very different from the others in productiveness, and also in physical, chemical, and biological properties. In order to get a measure of some of the physical differences, tests were made of the plough draught by means of a dynamometer. The results obtained up to the present show that heavy dressings of farmyard manure on this type of soil have very little effect on the draught but the tendency is to increase it.

Chemical fertilisers on the other hand tend to give a lower plough draught than farmyard manure, and small applications of lime bring about disease. Certain other investigations have obtained a decrease from the use of lime, but in these cases larger amounts were used.

The amount of soil moisture has an influence on plough draught - the draught tending to increase in this soil as the moisture decreased. It was difficult to get comparable moisture conditions in carrying out the experiment, since the effect of farmyard manure is to increase the soil moisture.

FERTILISERS.

Residual Effect of Acid Phosphate and Rock Phosphate. *Baker, W. G., Journal of the American Society of Agronomy, Vol.* 17, *No.* 3. *Geneva, N.Y.*, 1925.—The author's experiments were carried out on Iowa (U.S.A.) soils in order to ascertain how long an application of phosphatic fertilisers will be of practical value to crops. An account is given of results obtained by other workers. Experiment Station reports, greenhouse tests and field experiments extending from 2 to 8 years were studied.

The residual effects of both acid phosphate and rock phosphate continued to be shown at the close of the tests.

The increases in yields from the acid phosphate were usually higher the first year than in later years. In the case of rock phosphate the gain was less the first year or two, after which it was about uniform to the close of the tests. Rich soils gave more and quicker response to rock phosphate applications than poorer soils.

Clover possessed a higher power to utilize phosphates than maize or small grains. Early growth, maturity and quality were increased.

High grade acid phosphate was more slowly available on clays than on silt loams or loams.

Larger residual effects were shown from acid phosphate on soil containing lime than on acid soils.

The rate of exhaustion of the phosphorus in 44 per cent. acid phosphate was 12·3 per cent. the first year, 8·9 per cent the second year and 7·1 per cent. the third year, or a total of 28·3 per cent. in three years.

American Potash. *J. W. Turrentine, Industrial and Engineering Chemistry, Vol.* 16, *No.* 11., *November* 1924.—The author after having discussed generally the potash industry in America, both during the war and after, states that, in order that this industry may develop on a solid economic basis, it will have to depend on other large industries. In other words, potash should not be obtained alone, but should always be obtained as a bye-product or together with bye-products. The present American production of potash, which is calculated

at about 25,000 tons of K_2O annually, is entirely based on three large industries (cement, borax and alcohol) and constitutes a bye-product of these industries. Surveys have been completed of the three industries mentioned above and also of the blast furnace industry, which show a total tonnage there producible of 225,000 tons.

Such being the case, the author predicts that the quantity of potash obtained as a bye-product of the great industries will increase from year to year. America has also a second and practically inexhaustible source of potash in her minerals such as the greensand of New Jersey, the leucite of Wyoming, the alunite of Utah, &c. According to the author, the problem of extracting potash from these minerals by an economical process has nearly been solved. In this way attempts are now being made to combine the production of potash with the production of alumina (one of the principal constituents of many potash minerals), a product of great importance to the aluminium industry.

Moreover, from recent observations already recorded, it seems that in some parts of America there exist pure beds of potash salts.

The author concludes by saying that America could, therefore, in a short time, draw abundantly from these three large sources the amount of potash necessary for agricultural purposes, thus being entirely independent of European production.

ANIMAL BREEDING.

Inheritance of Horns, Wattles, and Colour in Grade Toggenburg Goats. *J. L. Lush, Journ. Hered., Vol.* 17, *pp.* 73-91, 1926.—Working with a herd of goats whose main use is for eating brush in a large pasture, the author has traced the inheritance of wattles (tassels) which appear to be due to the action of a single pair of factors, the tasselled condition being dominant and in no way sex-linked. The matings of untasselled animals produced 73 kids without wattles and three doubtful exceptions. Matings of wattled by wattled gave 32 wattled kids and 11 without wattles; and mating of wattled by non-wattled gave 21 of each category, all of which is in accord.

Regarding the inheritance of horns, the writer confirms the observations of Crew and Asdell that these are inherited in the same manner as in cattle, the polled condition being dominant. This, however, ignores the existence of scurs. The writer notes that he found one case of this. In colour, the writer produces nothing conclusive. He suggests that whole white and black are dominant to other colours as well as a pattern of extensive white spotting.

These results substantially agree with the work being at present carried on in this country, excepting that the scurred condition appears to be far more common here than in Texas. Until the mode of inheritance of scurs has been properly traced, it cannot be said that the manner in which horns are inherited has been discovered.

Œstrual Hormone and other Gland Extracts in the Treatment of Functional Sterility. *H. S. Murphy, G. W. M'Nutt, B. A. Zupp, and W. A. Arthur, Jour. Amer. Vet. Assoc., Vol.* 68, *pp.* 443-454.– Cases of sterility in cattle, due to various causes, were treated with varying success by the authors. In several cases the extrusion of the *corpus luteum* failed to bring on the beat period. This was followed by the intravenous injection of œstrual hormone, resulting in the cows "settling" to the bull, although they had been sterile during the past four years. The cows that "settled" usually did so after the first injection. There were five successful treatments and four without result. These experiments cannot be taken as in any way conclusive, but they are suggestive. Apparently the use of the hormone gives, in certain cases, just that impetus which is required to bring the reproductive organs into action. This is in accord with work already done on smaller animals.

The Breeding Season in the Goat. *S. A. Asdell, Brit. Goat Soc. Year Book, pp.* 32-36, 1926. –The reason for the restricted breeding season in the goat is quite unknown except that it occurs so that the offspring are born in the spring of the year. From an examination of the "Kid Register" of the British Goat Society the highest percentage of fertile matings takes place in October and November, having respectively 28·3 and 24·4 per cent. While September and December, the months at each side of the peak, have 15·1 and

11 9 per cent., the percentage of fertile matings is higher during the early months of the year, averaging 4 per cent. from January to March (inclusive), than for the three corresponding months, June to August, averaging 2·3 per cent. May has the lowest production, 0·4, followed by June with 0·6 per cent. A cool summer produces earlier matings than a hot one, resulting in as much as two months' difference.

Seasonal Distribution of Twin Births in Cattle. *L. J. Cole and A. Rodolfo, Wisconsin Bulletin, No* 373, *pp.* 87-88.—From American Hereford and Aberdeen-Angus herd books for 1923 it is shown that the average number of twin calves per 1000 cows calving is 4·65. The seasonal figures vary considerably. They are lowest in March at about 3·2 per cent., in June 4 per cent., and are highest in August at 6·2 per cent. The conclusion is that if twin calves are desired there is a somewhat greater likelihood of obtaining them if the mating is in November. No reasons are given to explain why this is so. No figures as to total numbers examined are given.

On Fertility in the Domestic Fowl. *F. A. E. Crew, Proc. Roy. Soc. Edin., vol.* 46, *pp.* 230-238.—Working chiefly with White Leghorns, the males being vigorous yearlings, it was found that fertile eggs can be expected within 24-48 hours after the introduction of the male though the onset of fertility varies with different matings. The length of life of the sperm within the body of the female is about 15-20 days, though in exceptional cases it may be greater, and although this fertility endures for this period, eggs laid after the first week commonly fail to complete their development.

Another interesting point is that the introduction of another male reduces the period of the duration of the fertilising power of the sperm of the male removed. If one male is replaced by another, the influence of the first sire will have disappeared in 7-10 days. This fact supports the conclusion previously reached, that fresh sperm is far more functionally active than is stale. A great deal depends on the vigour of the male, the impress of the second male differing in different cases. A Redcap male sired no chicks after the fifth day; while Leghorn influence was exhibited as late as the ninth. "Sperm of different males that differ in genotype and in general physiological fitness differ in their relative functional quality, and, if they are exposed one to the other, exhibit a competitive action. The difference may be one of relative motility."

ANIMAL NUTRITION.

The Role of the Antiscorbutic Vitamin in the Nutrition of Calves. *L. M. Thurston, C. H. Eckles and L. S. Palmer, Journ. Dairy Science, Vol.* 9, *No.* 1, *January* 1926.—Two experiments were carried out to test the requirements of calves for vitamin C. In the first experiment 4 grade calves were used, 2 control and 2 experimental. The ration consisted of oxidised milk until the calves were 6 months old, autoclaved alfalfa hay substituted later by oat straw, with a grain mixture of maize, oats and linseed oil meal. Butter-fat was added as a source of vitamin A and all the calves received a supplement of salt and calcium carbonate. The two control animals received a supply of lemon juice, changed later to tomato juice, to supply vitamin C. All the feeding stuffs had previously been tested on rats for their vitamin C content and found deficient.

Signs of stiffness in all the animals were noted during the experiment, which disappeared when cod liver oil was substituted for butter-fat. Some scurvy-like lesions were also found, and a second experiment was tried with more severe conditions relative to vitamin C deficiency.

In this experiment 4 calves, 2 weeks old, were placed immediately under experimental conditions minimising the possibility of vitamin C storage. A mixture of timothy hay and wild hay was used in place of oat straw; while cod liver oil was used instead of butter-fat as a source of vitamin A, the grain mixture remaining the same.

At the end of a year all the calves were in perfectly normal condition, so that under practical conditions, even where poor feeding practices are followed, there is no reason to believe that the well-being of the calf will be affected by a shortage of vitamin C.

The authors state that the stiffness noted in the first experiment and the hæmorrhagic areas may be attributed to a deficiency of vitamin A or of mineral matter rather than to a deficiency of vitamin C.

The Role of Vitamin A in the Nutrition of Calves. *R. Jones, C. H. Eckles and L. S. Palmer, Jour. Dairy Science, Vol.* 9, *No.* 2, *March* 1926.—The characteristic symptoms of vitamin A deficiency, determined in the case of small laboratory animals, are xerophthalmia, respiratory trouble, intestinal disturbances and death, and with mature animals, failure of normal reproduction. An experiment was undertaken to determine whether ruminants, as represented by calves, required a supply of vitamin A for normal growth and well being.

Control and experimental groups of calves were given untreated whole milk for a limited period and then changed to the vitamin A-free experimental rations which had previously been tested on rats for their vitamin A content. This experimental ration consisted of milk, treated in a manner thought to destroy any vitamin A present, later changed to skim-milk made from oxidised skim-milk powder, white corn (maize) as a source of vitamin B and dried beet pulp as a roughage (wheat straw as a roughage was found to be a good source of vitamin A). Lemon juice to supply vitamin C was given to some of the calves but was omitted from the ration of the others, as it had previously been found that calves do not require vitamin C for normal growth. Mineral supplements of calcium carbonate and calcium phosphate were added to the ration of all the calves, while cod liver oil was included in the ration of the control animals as a source of vitamin A.

All the animals in the control group receiving cod liver oil grew normally and maintained a healthy condition throughout the experiment. The animals in the experimental group, with one exception, showed the characteristic symptoms of vitamin A deficiency, loss of weight, scouring, running at the eyes and lack of vitality. These symptoms gradually disappeared, however, on the addition of cod liver oil to the ration.

The authors conclude that while there would be little danger of calves suffering from vitamin A deficiency on a ration of whole milk and a suitable roughage, the chance of a deficiency may be considerable if calves are fed on milk substitutes.

The Effect of Minerals in Overcoming Breeding Difficulties in certain Sows. *R. G. Baskett, Agricultural Progress, Vol. III,* 1926.—This gives an account of an investigation on the number and vitality of litters from sows before and after receiving a mineral addition to their ration. At the farm where this investigation was carried out trouble had been experienced in raising litters to the weaning stage, and this was attributed either to the effects of inbreeding or to the boar. Trials, however, showed that sows in the neighbourhood produced good litters by the boar and equally bad litters were obtained when an outside boar was used.

Before the system of feeding a mineral mixture was tried, the sows were on pasture with a small addition of a ration consisting of maize meal, pollards and meat meal. From 7 sows only 49 young pigs were obtained, an average of 7 per litter. Of these 49 only 26 or 3·7 per sow survived at 5 weeks, and only 17 or 2·4 per sow reached the weaning stage.

Before the next farrowing these sows received, as part of their ration, a supplementary mineral mixture consisting of ground limestone, steam bone flour, salt, iron oxide and sulphur. They produced 73 young pigs or an average of 10·4 per sow, of which 50 or 7·1 per sow were alive at 5 weeks and at weaning. This shows an increase of 48·5 per cent. in the average number of pigs at birth and an increase of 19·58 per cent. in the average number alive at weaning.

The field in which the sows were run was excessively sour with a very high lime requirement, and it seems probable that calcium and phosphorus were the limiting factors in the mineral deficiency of the sows.

Salting Pork on the Hoof. *J. M. Evvard and C. C. Culbertson, Iowa Agri. Expt. Station, Leaflet No.* 9, *November* 1925.—The Iowa Experiment Station has conducted several pig feeding trials comparing the effect on growth of rations with and without the addition of salt. In the first experiment one group of pigs received no additional salt in their ration, while a second group received all the salt they would take—free choice style. The group receiving the extra salt clearly outgained the other group, making on an average 0·4 lbs. more weight per pig per day. The food requirement was 574 lbs. per 100 lbs. gain for the no salt group and only 467 lbs. for the salt group. One half pound of salt saved in this case 107 lbs. food. In addition the pigs in the salt group were ready for market 47 days earlier than the pigs in the no salt group.

Too much salt in the ration, however, may have a deleterious effect on the growth of pigs, as shown in another experiment where to the basal ration (containing 40 per cent. blood meal) of a control group extra salt was added to the same ration of an experimental group. The average daily gain of the two groups was practically the same, and this is explained by the fact that the blood meal itself contained sufficient salt.

In another experiment, more fully detailed, six groups of pigs received differential treatment in regard to the amount of salt in the ration. Group I had no extra salt, Groups II, III, IV and V had 1, 2, 4 and 8 lbs. salt added per 100 lbs. food, while Group VI had salt on the free choice system. The self-fed pigs easily excelled the unsalted ones during the entire experiment of 180 days, consuming only 399 lbs. food per 100 lbs. gain as compared with 494 lbs. for the no salt group. Group II receiving 1 lb. salt per 100 lbs food was not far behind the self-fed group, consuming 412 lbs. food per 100 lbs gain. Groups III, IV, and V showed the poorest returns, due to an excess of salt in the ration.

It is concluded that the best way to give salt is to give it either free choice style or include it in a well compounded mineral mixture.

A Comparison of Different Forms of Milk in a Ration for Growing Chickens. *L. E. Card, Journ. Poultry Science, Vol. V, No.* 4, 1926. There is little evidence in the literature to show whether there is any difference in growth promoting qualities between liquid forms of milk and condensed and dry milk products, and an experiment was undertaken to test the effect of these on growth in chickens.

Four groups of chickens, 4 weeks old, received the same basal ration. The first group had in addition sour skim milk *ad lib.*: Group II fresh buttermilk *ad lib.*: Group III condensed buttermilk in paste form and Group IV dried buttermilk. During the experiment bacilliary white diarrhœa broke out and resulted in a heavy mortality in all groups.

At all the weighings during the experiment, except the first, the average weight of the dry buttermilk group was greater than the average weight of any other group, but only on one weighing (at eight weeks of age) was the difference between the average weight in Group IV and the next heaviest group actually significant. At the end of the experiment, which lasted 22 weeks, there was a difference of only 41 grams between the average weight per chick in Group IV, the heaviest, and Group I, the lightest group, and this difference is insignificant,

Thus the problem resolves itself into a question of the convenience in feeding of the different kinds of milk, their availability and cost.

The Influence of the Period of Heat on Milk Production. *A. C. M'Candlish, Jnl. Dy. Sci., Vol* 9, *No.* 1, *p.* 65, 1926.—The milk production of cows on the day on which they are mated is compared with their production on the 3 days preceding and 3 days following. In all 868 cases were available. It was found that there was apparently a small decrease in milk yield on the day of mating and the day following, while the average production on the two days before appeared to be slightly above normal. There were very wide variations in individual cases and even with the same animal at different dates.

A Study of Calcium and Phosphorus Balances with Dairy Cattle. *R. C. Miller, Jnl. Dy. Sci., Vol.* 9, *No.* 1, *p.* 78, 1926.—The results of 12 determinations of calcium and phosphorus balances with 3 milking cows are presented. All of the calcium balances except 1 and all but 2 of the phosphorus balances were negative. It was found that a better assimilation of calcium resulted where clover instead of timothy hay was fed, and it is noted that the protein of clover is of higher quality than that of timothy.

The Effect of Environmental Temperature on the Percentage of Fat in Cow's Milk. *W. P. Hays, Jnl. Dy. Sci., Vol.* 9, *No.* 2, *p.* 219, 1926.—The influence of temperature on the fat percentage in milk was studied with a herd for a period of 258 days, while 7 controlled temperature trials were run with 2 Jersey cows. It was concluded that there was a range of temperature between 70° and 90° F. within which the milk of lowest percentage is produced. A variation either way in the temperature will increase the fat percentage in the milk.

Protein Requirements of Dairy Cows. *A. E. Perkins, Ohio Agr. Expt. Sta. Bul.* 389, 1925.—Rations containing from 8½ to 33⅓ per cent. of protein were fed to producing cows for a total of 51 lactations, and a high protein content in the ration was not found to have any marked or consistent effect in increasing the productive efficiency of the ration. It was concluded that the older feeding standards call for unnecessarily high amounts of protein ; that the actual maintenance requirement is less than that prescribed in the standards ; that above this maintenance requirement an amount of digestible protein only slightly greater than the protein content of the milk appears to be adequate ; and that beyond this point production seems to follow the total digestible nutrients of the ration rather than the protein content.

The Importance of Well Cured Hay in the Ration of Dairy Cattle. *O. E. Reed and C. F. Huffman, Mich. Agr. Col. Quart. Bul., Vol.* 8, *No.* 1, *p.* 10, 1925.—In studying the cause of malnutrition in dairy cattle on rations lacking hay, wheat straw was added to a ration of yellow maize, maize gluten, cottonseed meal and salt fed to heifers. The wheat straw did not induce normal development.

Feeding Experiments at Fredericton, N.B. *C. F. Bailey, Canada Expt. Farms, Fredericton, N.B., Sta. Rpt. Supt., pp.* 10–13, 1923.—Mature maize silage was found to have a greater value for milk production than sunflower silage, but immature maize silage was not so valuable. Turnips maintained the milk flow at a higher level than did maize or sunflower silage.

Heifers made fair growth on maize silage, hay and straw, but not so large gains as when receiving a full allowance of hay.

Feeding Experiments with Dairy Cattle at the Kapuskasing Experimental Station. *S. Ballantyne, Canada Expt. Farms, Kapuskasing, Ont., Sta. Rpt. Supt., pp.* 5–9, 1923.—Sunflower silage was of about the same value for milk production as that from oat, pea and vetch silage. Calves made daily gains of 1·03 lbs. on sunflower silage as compared with 1·32 lbs. on oat, pea and vetch silage.

The Volume of the Ration. *Leroy, A. M., Revue de zootechnie, la revue des éleveurs, Year* 4, *No.* 5. *Paris*, 1925.—In the problems of the scientific feeding of animals it is not enough to determine the number of forage units contained in the daily ration, to calculate the quantity of energy necessary to an animal organism situated in given conditions of production, to investigate the value of the minimum daily supply in proteins, the presence of which in the foods enables the symptoms of lack of nitrogen to be avoided, but it must also be assured that the daily quantities of forage which the application of the usual method provides are in proper relation to the digestive capacity of the animals in question, especially so that excess may be avoided.

Species of domestic animals react differently under the influence of a ration too rich in indigestible matter : ruminants have a greater capacity than horses for the consumption of bulky foods ; pigs, proportionally to their weight, have the smallest digestive capacity.

Each animal should receive a given quantity of dry matter, neither too much nor too little, which depends on its species, weight, age and the nature and intensity of its production. It is therefore necessary to determine the coefficient of bulk of each of the forages capable of being included in the ration, that is to say, the quantity of dry matter, expressed in kg., contained in a forage unit of each of the foods considered.

In a table the author calculates the coefficients of bulk of some of the principal forages based on the fact that green forages represent, in proportion to the volume of the ration, the best balanced category of foods ; he deduces from this that the coefficient of bulk of rations should as nearly as possible approach the figure which corresponds to meadow grass, namely 1·3.

In a second table are shown the amplitude of variations in the coefficient of bulk of the ration admissible for each species and in each particular case. The practical application of the preceding data are then studied by considering a type ration for a dairy cow of 700 kg. giving 30 litres of milk per day. The ration contains 15·03 forage units and 21·89 kg. of dry matter ; the coefficient of bulk is therefore :

$$\frac{\text{dry matter}}{\text{forage value}} = \frac{21\cdot89}{15\cdot53} = 1\cdot46.$$

It is evident that it is not possible, without causing a loss of appetite and consequently a decrease in production, to replace in the proposed ration a portion of the concentrates by hay or straw.

This method of calculating the bulk of the ration is simple and enables the content in dry matter of a ration to be usefully modified, without modifying its forage value, that is to say to determine the possibility or otherwise, from a physiological point of view of food substitutions, which may appear desirable on account of the market rates of foodstuffs.

Yeast as Supplementary Food for Dairy Cows. *C. H. Eckles and V. M. Williams, Journal of Dairy Science, Vol. VIII, No. 2. Baltimore*, 1925.—Researches on the effect of the use of yeast as supplementary food for cows in milk and its influence on the content in vitamine B of the milk produced.

The authors used, as animals for the experiment, 8 cows divided into two groups fed as follows :

	Group 1.	Group 2.
1st. Period (40 days) ...	Basal ration + yeast	Basal ration.
2nd. " (40 ") ...	Basal ration	Basal ration + yeast.
3rd. " (40 ") ...	Basal ration + yeast	Basal ration.

The first ten days of each period are considered as a trial period and the comparison of results is made for the 30 following days.

The basal ration was composed as follows : — lucerne hay, maize silage, dry beet pulp and a concentrate (ground maize 2, ground oats 2, wheat bran 2 and linseed cake 1). The fodders were given *ad libitum*, the concentrate was fed in such proportion as to give slightly more than protein and energy needs required, calculated according to Armsby's standards, so that the yeast supplement might act fully, without limitation consequent on a deficiency of food.

Dry commercial yeast was used at the rate of 55 gm. per day and per kg. of milk produced (25 gm. per day and per pound). The following are the results obtained : In Group 1, the average yield of milk during the periods in which the supplement of yeast was fed was 26·4 lbs. per day against a daily average of 26·5 lbs. during the 2nd period without yeast.

For Group 2 the average yield was 25·6 lbs. for the periods with basal ration against 25·2 lbs. for the period with basal ration + yeast. As regards the average daily yield in fat the respective figures were :—

Group 1 : 0·942 lbs. without yeast and 0·957 lbs. with yeast.
Group 2 : 0·897 lbs. with yeast and 0·925 lbs. without yeast.

The addition to a normal ration for dairy cows of yeast to the extent of 25 gm. per day and per pound of milk produced does not cause either an increased yield nor an increase in the richness of the milk ; further, no special effect was noticed either in the state of health or in stimulation of appetite.

DAIRYING.

The Influence of Different Methods of Pasteurisation by Heating on the Digestibility of the Albumenoid and Mineral Constituents of Milk. *E. F. Terroine and H. Spindler, Le Lait, Year V, No.* 43. *Lyons*, 1925.—It is important that only milk free from injurious micro-organisms should be delivered for public consumption, but its composition and properties at the time of secretion should have been modified as little as possible. These two desiderata appear to be contradictory, for to destroy the micro-organisms, the best method is to heat the milk, thus risking modification of its composition and the impairing of its physical structure if not the composition even of its constituents.

The authors have made a comparative study of the influence of low and high temperature pasteurisation, and the Stassano process.

Cow's milk, sometimes fresh, sometimes subjected to the various processes of pasteurisation under examination, was administered to young pigs of the

same age and weight (8-10 kg. when the tests commenced), during the growth period. The quantity of milk given is calculated on the basis of its caloric energy, at the rate of 150 calories per kg. of live weight.

In a first series of tests, various animals were compared with one another, and in a second the comparisons were made on the same animal receiving a different milk for each test period, lasting a week.

Every day mixed cow's milk was utilised. The first part is given in its natural state; three other portions are treated respectively by one of the following processes:—

Low temperature pasteurisation—heating to 63° C. for 25 minutes, with mechanical stirring, then cooling.

High temperature pasteurisation—heating to 95° C. for one or two minutes, then cooling.

Stassano *process* heating to 75 C. for four or five seconds, the milk flowing out in a thin layer continuously, then cooling.

The results of the tabulated tests enable the following conclusions to be drawn:—

(1) Milk, fresh or subjected to heating by the high temperature pasteurisation process, the low, or the Stassano gave identical coefficients of digestive utilisation of nitrogenous substances and ash.

(2) The values obtained for the coefficients of digestibility of the proteins of cow's milk by the pig are exactly the same as those previously observed by various authors for the digestion of cow's or human milk by children. The specific origin therefore does not entail any difference in digestibility.

(3) Even with a very young animal of rapid growth, feeding with milk alone only allows a poor assimilation of nitrogen, taken at the rate of 150 calories per kg. by young pigs of 8 kgs. weight, the milk only leaves in the organism 50 per cent. of the proteins it contains.

Such method of feeding therefore entails a considerable waste of nitrogen.

Dairy Farming on Arable Land. *University of Leeds, Bulletin No.* 138 *Leeds*, 1925.—The Bulletin gives an account of a system of cutting and feeding of green forage to dairy cows, to supplement or take the place of pasture during the grazing season. The work was carried out at the Solling Farm, Rawcliffe, Yorkshire, from 1920 to 1924.

The Bulletin describes the experiments and the results obtained, the factors which affect the relative efficiency of soiling crops and grass pasture for milk production, the possibilities of reducing the cost of milk.

In an appendix are shown details of cropping, annual valuations, tables comparing economic results with those of other farms in Yorkshire, graphs of milk yields and charts of schemes of cropping.

The Effect of Season on Milk and Fat Production of Jersey Cows. *C. Elmer Wylie, Journal of Dairy Science, Vol. VIII, No.* 2. *Baltimore*, 1925.—It is a well-established fact that the milk production of a cow decreases as the lactation period advances, and that the percentage of fat in the milk increases in the course of the same period. On the other hand recent researches have shown that there is an important relation between the season of the year and the quantity and richness of the milk produced.

In order to determine the combined effect of the lactation period and the season on the production and richness of milk, the author has examined the records of over 2900 cows included in the "Register of Merit Record of Jersey Cows" of the American Jersey Cattle Club.

Cows which commence their lactation periods in May and in July give on the average richest milk respectively in the ninth and seventh month of their lactation periods. Those which commence in June give a higher average percentage of richness of milk in fat from the eighth to the tenth month of their period of lactation than during the twelfth month.

The average annual percentage of fat in the milk was highest for cows commencing their lactation periods in July, August, September, and was higher by about 5·45 per cent.

The annual production of milk was highest for cows commencing their lactation in July, October, November, December, January, February and March; it was in all cases more than 8800 lbs. (3992 kg.).

The production of cows commencing their lactation in April, May, June,

August and September was less; the average difference between the two groups was, however, slight.

The average annual production of fat was highest for cows calving in July, October, November and December, in all cases exceeding 477 lb. (216 kg.). That of cows calving in April, May and August was less and always below 468 lb. (212 kg.).

The season of calving and the period of lactation affect the richness of the milk, in the sense that the richest milk is obtained a certain time before the end of the lactation period depending on the month in which the cow has calved.

LIVE STOCK:—*Cattle.*

Austria: Fundamental Criteria for the Judging and Awarding of Prizes to Cattle in Lower Austria. — Until recently periodical judgings of bulls and calves were carried out at all the stock-breeding centres in Lower Austria. Every owner of stock had the right to present his animals for inspection, even if they were not bred by himself. Only one or another of the head of cattle presented were examined, and when the stock from a given farm failed several times to come up to the standard required by the Judging Committee, recognition was refused.

This form of cattle show, viz. exclusively for calves, is now altogether given up, as it was considered that, in the absence of evidence as regards progeny and functional aptitudes, the judging tended to be based purely on conformation, and thus not infrequently led to disappointment at a later period of the animal's history. Hence at the present time, instead of calves only, there are presented for examination young and full-grown animals, cows, beef cattle and heifers. Only animals registered in herd-books and their descendants can be approved.

In this way it becomes possible, as it was not before, to judge and form an estimate of the stock-breeding farming activities of each member of the association. There is in addition a new prize award scheme, which brings into more prominence the evaluation of hereditary characteristics and facilitates the awarding of the prizes in classes corresponding to the points of the animal shown.

Prizes are being awarded by the Lower Austrian Chamber of Agriculture and the Federal Ministry of Agriculture; and also there will be prizes given by the rural district chambers, the associations and the Communes. These will, however, be of less value than those given by the two first-named bodies. The judging is carried out by a sworn committee appointed for the purpose. Farmers who have an official position in the association or reside in the administrative area of the association cannot sit on this committee. Members are proposed by the Lower Austrian Chamber of Agriculture and the Provincial Government appoints a member in its turn.

For the awarding of prizes note is first taken of the evidence produced by the exhibitor in respect to the progeny and the functional aptitudes of his animals, and only after that is judgment given on each animal and in accordance with a given scheme, established by Decree of the Provincial Government on the basis of the Law on the promotion of stock-breeding. This scheme provides for four groups, further divided into sub-groups, represented on the following table in regard to the maximum number of points obtained.

Head and neck	5
Back line and width of back	4
Forequarters, width of chest behind the shoulders barrel, shoulders	4
Hindquarters, croup, width of thigh, muscles, sex organs ...	4
Length of body	5
Structure of limbs and general bearing	4
Skin and hair	3
Milk-yielding aptitude	14
Meat producing aptitude	8
Work aptitude	8
Breed and coat	5
Progeny	10
Condition of health and constitution	8
Development	7
General impression	10

Animals obtaining more than 85 points receive the first prize, those obtaining from 80 to 85 points receive the second prize, and cattle with 70 to 80 points

receive the third prize. For animals for which there is evidence forthcoming, authenticated by the Association, in respect of the sire and the dam, and evidence, similarly supported, as to the milk-yielding capacity of the dam, for at least two years, the owner receives an extra prize of 25 per cent., given by the Provincial Chamber of Agriculture. The prize is subsequently increased by 50 per cent., when the breeder can bring forward evidence in respect to the pedigree of the animal presented.

The acceptance of the prize binds the breeder to devote the animal presented to breeding purposes for the space of at least two years. Young prize bulls must be sold only to farmers or Communes who undertake to place them at the disposal of the public breeding stations in the territory of Lower Austria for the space of at least one year.

The Lower Austrian Chamber of Agriculture has the exclusive right of purchasing animals winning the prizes it awards. If the exhibitor puts the animal to uses other than those to which he is bound by the award, he must restore the prize, and also incurs a fine equal to half its value. The object of this proviso is to prevent the breeder from selling the animal and to oblige him to use it for the purpose of improving the breed.

In addition to these prizes for individual animals, others are offered for whole families of animals shown: the cow and at least five descendants. Each exhibitor may claim for his animals of one group only one prize, but for any remaining animals that reach the prize standard, he may receive a certificate stating the nature of the prize they would have taken.

Besides these approval exhibitions, others are organised for bulls, and the special purpose of these is to provide a classification of the stock for the Stock-Breeding Committees, and to afford the Communes the opportunity of purchasing approved and prize animals for service uses. As regards organisation and the award of prizes, the same rules are followed in these exhibitions as in the former kind. The acceptance of a prize binds the breeder to devote his bull to breeding purposes only for a period of at least a year, or to hand the animal over only to an individual purchaser or organisation which will undertake to put it for the period of at least six months to the disposal of the public breeding stations of the territory of Lower Austria. The total amount of the prizes is fixed year by year by the regional Chamber of Agriculture.

This new scheme for approval of cattle has been very generally adopted in Lower Austria, although imposing much stricter conditions on the breeders than formerly.

Poultry.

The Effect of Lactic Acid in the Control of Intestinal Disease of Poultry. *B. T. Kaupp and R. S. Dearstyne, Poultry Science, Vol. IV.*—The investigation has a practical bearing on the lactic acid value of buttermilk as used for poultry feeding, since the lactic acid is not destroyed in the preparation of either condensed or dried buttermilk.

By these experiments it is shown that the effect of lactic acid in milk is to create a field in the intestinal tract, unfavourable to harmful bacteria.

INSECTS AND PESTS.

Insect and other Invertebrate Fauna of Arable Land at Rothamsted. *H. M. Morris, Annals of Applied Biology, IX.*—A method of taking soil samples for determining the numbers of Insecta, Myriapoda, Oligochæta, Acarina, &c., present in the first 9 inches of soil is described, and the functions of this invertebrate fauna discussed. Soil was examined at definite intervals during a year and the numbers present at different depths compared on each of two plots receiving widely different manurial treatments. Of 15 millions of invertebrates per acre on the plot receiving 14 tons of dung per acre anually since 1839, 2·47 million were insects. The greatest number of all kinds of invertebrates occurs in the first 3 inches of soil. The greater number of invertebrates found in the manured plot does not indicate a greater increase in the number of organisms directly harmful to the growing crop. The larvæ of Elateridæ, Tupulidæ, and Hepialidæ occurred in equal numbers in the two plots. It is suggested that the great difference observed between the numbers of insects found in arable land and those found in pasture (reported in a

previous paper by the author), and the greater depth of penetration, is due to the better æration and drainage caused by cultivation.

The Destruction of Wireworms. *A. Spuler in Jour. Econ. Ent., Geneva, N.Y., U.S.A.*, 1925.—One of the wireworms, *Pheletes occidentalis*, has become a very harmful pest of gardens and arable land in Washington State, where the infestation varies from 80,000 to 400,000 an acre. Soil fumigation with calcium cyanide has been effective, but is too expensive, as even under favourable conditions little result follows the application of less than 300 lb. per acre. It has been discovered, however, that before soil fumigation is applied, the wireworms in the area may be concentrated within a limited radius by the use of food baits. Fields to be baited must be free of weeds, such as mustard, which have a special attraction for wireworms. Further, they should be baited early in the year before the pests have come to the surface soil. They should be treated with flour, or better with germinating seeds of almost any garden vegetable, which prove more attractive to the beetle larvæ. Baits should be allowed to remain for some time in the soil before fumigation takes place, as the concentration of the wireworms is a very gradual process. As a result of the use of such baits 100 lbs. calcium cyanide per acre has been found sufficient to kill a high percentage of wireworms.

The Inhabitants of Apple Trees. *S. Stuart Light in Ann. and Mag. Nat. Hist., Jan.* 1926, *p.* 126.—With the idea of obtaining a complete survey of the pests of apple trees, the author made a study of the animals and plants which are to be found upon the bark or under the bark. The result shows that apple bark harbours an extraordinarily large and varied assemblage of organisms. Thus the animal life falls into seven different orders. There are many insects of various kinds, taken mostly during the winter months when they were hibernating under the bark, and ranging from earwigs and the primitive spring-tails to beetles, moths, butterflies and hymenoptera, more than 95 recognisable species in all. Many spiders and mites were found, especially on neglected trees where the bark was flaky or bore prolific growths of moss or lichen, and myriapods, molluscs, woodlice and worms were also represented—these groups adding at least 14 additional species. So that well over 100 species of animals were represented in this mixed population. In addition, however, there was an assemblage of vegetation which was only a little less varied. It contained lichens, mosses, liverworts, algæ and higher plants. Amongst the latter it is curious to notice that growing on the bark of old apple trees in the Bristol district were such as polypody fern, seedling yew trees, gooseberry bushes, strawberry plants, burdock, germander, speedwell, ragwort and marsh-thistle. The author observes that a condition of permanent dampness leads to the deterioration of trees and the growth of epiphytes, and this condition may be due to various causes such as the position of the orchard in a hollow, the inefficient draining of the soil, the proximity of a body of water, and the overgrowth of the orchard by long grass and other vegetation.

IMPLEMENTS AND ENGINEERING.

Power for the Farms from Small Streams. *A. M. Daniels, C. E. Seitz and J. C. Glenn, United States Department of Agriculture, Bulletin No.* 1430. *Washington, D.C.*, 1925.—The purpose of the Bulletin is to acquaint farmers with the possibilities of developing the power of small streams by converting it into electrical energy, and the uses to which such power can be put. Information is given as to avoidance of unnecessary expense, the estimation of the available power of a stream, and sources from which additional information may be obtained in regard to approximate cost of installing a plant.

Research on the Applications of Electricity to Agriculture.—The question of the use of electricity on the farm is one of importance in view of the advantages of this source of energy. However, as regards rural needs, the cost of production is often a relatively small item as compared with the cost of transmission, distribution and transformation. One of the chief difficulties is that the consumption of electrical energy by the average farmer is relatively small. To establish an electrical service the agricultural uses of electricity must be increased, so that a rate can be charged which will be advantageous both to the central station and the farmer.

The following are some of the chief applications of electricity in agriculture:—lighting, heating, in the canning of fruit and vegetables and the making of preserves, the dehydration of fruits, the electrical treatment of seed, the stimulation of crop production, increase of egg production, heating of incubators, spraying and heating of orchards to prevent injury by frosts, and as a source of power, both for ploughing and cultivating and for the many machines in use on a farm.

The variable results obtained so far indicate that not enough is yet known about the main factors. The use of electricity generally in farm operations will probably come about from the development of the use of smaller power units.

The scientific application of electricity to agriculture requires a large amount of fundamental agricultural research and also of engineering experimentation, to ascertain power requirements and exact electrical applications. —*Experiment Station Record, Vol.* 51, *No.* 4, *Washington*, 1924.

Germany: Courses in Rural Mechanics in Bavaria.—The Bavarian Government about ten years ago instituted agricultural chambers in various places (*Landwirtschaftsstellen*), which encouraged agricultural progress and served as advisory bodies for agriculturists. There are at the present time 98 of these organisations, including in round figures 200 special advisers who act under the Bavarian Ministry of Agriculture. The Ministry in 1920 arranged that the *Landwirtschaftsstelle* should hold, so far as possible every year, courses of practical rural mechanics for the benefit of the cultivators of small and average sized holdings, adapted to local requirements in each case. Accordingly, the Ministry of Agriculture merely laid down in this connection the main outline of the scheme, leaving it to the *Landwirtschaftsstelle* to carry out the special applications in the different courses. Side by side with the theoretical instruction on farm implements and machines, care is taken to give the students practical acquaintance with their working, the putting together and taking apart of the machines and their separate parts. The courses are accordingly held in connection with visits to an agricultural machinery factory and a large repairing workshop, &c., where expert foremen give practical illustrations to the students as required. A visit to some large farm completes the courses.

So as to ensure success not more than 15 to 20 persons are admitted to the courses, and in case of need the courses are repeated with the same students. As a general rule, the instruction lasts for a week, at a time when farmers are relatively at liberty. The following are the statistics of attendance, &c. for the years 1921-22-23-24. In 1921 32 courses were held by 27 *Landwirtschaftsstellen*, attended by 570 students; in 1922, 57 courses by 47 *Landwirtschaftsstellen*, attended by 815 students; in 1923, 70 courses by 58 *Landwirtschaftsstellen*, attended by 1,315 students; in 1924 there were held 59 courses, arranged by 51 *Landwirtschaftsstellen* with 1,058 students.—(*Fr. Lang, Landwirtschaftliche Maschinenlehrkurse in Bayern, Münchner Neueste Nachrichten*, 17 *June* 1925.)

MISCELLANEOUS.

Italy: Development of the Agricultural Cinematograph.—This is now in course of full development in Italy and is making itself felt as a method of the first rank for the diffusion of progressive ideas in the country districts. Although not at the outset supported financially and otherwise as generously as it might, and should have been, by the competent State authorities, the agricultural cinematograph, owing to the efforts and the assistance of various agencies, societies, private individuals and different administrative bodies, has succeeded in proving its importance, so that it is now regarded as an indispensable adjunct to instruction.

Propaganda by means of the cinematograph is organised by the "National Institute Cerere." Among the most important films are to be noted those on scientific fertilising, on cultivation of cereals, viticulture and fruit growing, industrial plants, control of plant diseases. Beginning with 160 films in 1920, the number was raised to 1200 in 1922 and to 2000 in 1924, while in the current year provision is being made for a larger number.

Roumania: The Development of Agriculture in Roumania as a result of Agricultural Reforms.—These reforms, which caused a complete change

in the distribution of cultivable land, have had a very favourable effect on agricultural production, according to the last official figures (1924). Both the yield and the quality of the wheat have improved, while the yield has increased in the years 1919-23 from an average of 8·39 to an average of 10·3 quintals per hectare. Live stock production has increased 19·93 per cent. within the same period. The quantity of crop and live stock products exported also increased considerably, namely, from a value of 34 million *lei* (in round figures) in 1919, to over 9 miliard *lei* in 1922.

The large estates, which, previous to the reforms, comprised 48 per cent. of all cultivable land, form only 8 per cent. at the present time, and the number of small holdings has doubled from 40 per cent. to 80 per cent.—(*La Réforme agraire en Roumanie et ses résultats d'après les derniers chiffres officiels fin* 1924, *Bucarest*, 1925.)

The Belgian Peasants' Union (*Boerenbond*).—On 1st June last the General Assembly of the Belgian *Boerenbond* was held at Louvain, attended by 2000 delegates of the respective agricultural syndicates. From the report for 1924 made by the General Secretary, Canon Luytgaerens, it appears that at the end of the year in question the number of the guild had risen to 1,133, including in all 98,706 members, representing as many families.

The work of the *Boerenbond* is carried on by the Secretariate in collaboration with the subordinate services: documentation, inspection, League of Farmwomen's Clubs, General Federation of Horticulturists. The intention of the Union is to promote both the general education and the technical knowledge of the members, as well as their social sense and feeling for co-operation. Every year the *Boerenbond* organises a series of "days of study," attended by about 800 representatives as a rule: it publishes two weekly journals and monthly reviews. In 1924 it published also eight treatises and technical manuals and arranged for the holding of 3,440 lectures to agricultural syndicates.

The *Boerenbond* carried on systematic action with a view to promoting vocational agricultural education, and for that purpose has established in nine centres courses of training for women teachers to give instruction in the elementary stages of rural household management, which courses were followed by 187 students. It took part also in the setting up of 22 district agricultural schools, intended for pupils who have already satisfactorily passed through the courses of elementary stages, or sections. On the other hand 263 of these elementary sections, established by the initiative or with the co-operation of the guilds, have entered successfully on their third year of existence. In 1924 the League undertook a campaign for the development of rural libraries and for the foundation of a technical agricultural library in connection with every syndicate.

The League of Farmwomen's Clubs, which included at the end of 1924 336 affiliated clubs with a total of 56,224 members, has organised 117 courses, each of 3 to 4 days, on various subjects of interest, in particular household science, in addition to a series of 4 "days of study" at Louvain, attended by 241 local organising members, and 8 provincial "days" for rural housewives, attended on each occasion by thousands of peasant women; 1,884 lectures were also given. The General Federation of Horticulturists arranged 178 lectures, held 17 local "days of study" for potato growing, undertook an educational journey in Holland and Poland, and organised several regional horticultural exhibitions. Competitions in cultivation were organised on a larger scale, and in the province of Antwerp alone 213 plots for rye and 274 for potatoes were planned for this purpose. The technical services — buildings, drainage and electricity — displayed great activity, and 1,485 analyses were made by the laboratory.

At the end of 1924 there were 112 local agricultural syndicates affiliated to the "General Federation of the Stock-breeding Syndicates." The department for small live stock breeding was in touch with 24 poultry keeping unions. The *Boerenbond* also continued to carry on valuable work in connection with tariffs taxation, mutual insurance, the housing crisis, war losses, and also more directly by the joint purchase and sale of eggs and butter, and the *Comptoir d'achat et de vente*, among its other activities, purchased for its members in 1924, 196,528 tons of fertiliser, feeding stuffs and other agricultural requisites. The value of these goods, together with that of the supplies of farm machinery and dairy equipment, amounted to more than 108 million francs.

There should also be mentioned the work, by no means unimportant, done in connection with agricultural credit, insurances and land improvement.

Italy: Measures in regard to the Cultivation of Cereals. - With the object of encouraging the growing of cereals in Italy to the utmost possible extent, a number of enactments have been issued which taken as a whole make systematic provision for the necessary organisation and the technical and financial requirements in view of the "cereal campaign" (*batglia del grano*). In the first place a Permanent Committee for Cereals has been set up; and the customs duties on wheat, the minor cereals and their derived products have been re-instituted.

In order to encourage the diffusion of motor ploughing, measures have been passed abolishing the duty on petrol if supplied to a farmer, at a sacrifice of 5,000,000 liras yearly; and increasing to 40,000,000 liras the sum set aside to meet the applications for loans for the purchase of special heavy implements and machinery designed for preparing land for ploughing in areas not previously considered suitable for field crops. In addition, a further allocation of 3,000,000 liras annually has been made for contributions, up to one fourth, towards the expense of purchasing similar appliances and for premiums payable to persons undertaking the breaking up of land.

A further development of the work of the *Cattedre Ambulanti di agricoltura* in the direction of propaganda and technical assistance for cereal cultivation is contemplated, and for this purpose the funds allocated to these bodies are increased by another three million and a half liras, the total allocation thus amounting to 7,000,000 liras. In addition, another 7,000,000 liras are being set aside yearly for the establishment in each commune of the Kingdom, at the State expense, of experimental fields for wheat growing on methods suitable to the district, and a further 4,000,000 are placed each year at the disposal of the Experimental Agricultural Institutes for grain cultivation. Five millions have been assigned to the work of promoting the more general use of selected seeds: the State contributing up to 50 per cent. to the establishment of consortia and associations undertaking the production and the distribution of such seeds.

In addition, Provincial Grain Commissions have been established and have been assigned the funds required for carrying out an intensive propaganda.

Provision is made for loans for working capital, and the agricultural credit institutions, which owe their existence to special laws, have been empowered to expend sufficient funds to carry out an effective propaganda scheme for cereal cultivation, and for this purpose it has been arranged to make loans to the value of 120,000,000 liras.

Steps have also been taken to encourage the construction of grain warehouses, following the procedure as to loans sanctioned by other decree-laws on agricultural land credit.—(*Gazzetta Ufficiale*, 18, 24 *and* 31 *July*, 8 *and* 9 *August* 1925.)

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FERTILISERS and FEEDING STUFFS in March, April and May 1926.

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	March.			April.			May.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
FAT STOCK :—									
CATTLE—	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.
Aberdeen-Angus ...	64 6	58 9	42 10	64 1	57 7	45 3	63 7	57 3	43 2
Cross-bred (Shorthorn)	60 9	54 7	39 2	60 7	54 4	39 5	60 0	53 5	38 8
Galloway	58 11	54 5	..	60 3	55 6	.	60 5	55 6	..
Ayrshire ..	58 5	50 5	35 7	59 6	51 6	37 6	58 9	50 3	37 4
Blue Grey	...	..	...	..	...	...	...	...	...
Highland .	...	...	. .	...	...	...	. .	.	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
VEAL CALVES .. .	16¾	12	6½	15¾	11½	5¾	16	10½	6
SHEEP—	under 60 lb. per lb. d.	60 lb. and upw'ds per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot .	16¼	14¼	11¾	16¼	14½	12	16½	15¼	12
Half-bred .. .	15¾	14¼	11¼	15¾	14¼	11¼	16	15	11¼
Blackface	15¾	13¾	11¼	15½	13¾	11½	15¼	14¼	11¼
Greyface	16	14½	11½	15¾	14½	11	16	14¾	11¼
Down Cross	16	14½	...	16	14¾	..	16	15	..
PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs . .	14 4	13 2	...	14 5	13 4	..	14 7	13 8	.
Porkers	14 9	13 9	.	14 10	13 11	...	15 2	14 4	..

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND—*continued.*

Description.	March. 1st.	March. 2nd.	March. 3rd.	April. 1st.	April. 2nd.	April. 3rd.	May. 1st.	May. 2nd.	May. 3rd.
STORE STOCK:—									
CATTLE—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head	Per head	Per head.
Aberdeen-Angus:	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings .	17 17	14 11	13 13	20 1	16 4	14 2	18 3	14 11	12 19
Two-year-olds ..	25 9	20 6	..	26 16	21 6	18 8	24 3	18 17	17 0
Cross-bred (Shorthorn):									
Yearlings .. .	17 5	14 1	11 17	18 2	15 6	13 5	17 2	14 3	11 16
Two-year-olds ..	24 5	19 7	16 13	24 7	19 4	16 3	23 2	17 18	16 11
Galloway:									
Yearlings	17 5	12 15	...	18 8	...	...	18 13	...	...
Two-year olds .	23 15	19 0	...	25 0	..	..	32 15	21 0	..
Ayrshire:									
Yearlings .			.	10 10	..		11 3	11 10	.
Two-year olds ...	..		.	..		...	18 18	16 5	..
Blue Grey:									
Yearlings	..	.		20 3	17 5	14 18		.	.
Two-year-olds ..	.	.	..	25 0	21 15	18 0	...	..	
Highland:									
Yearlings ...	.		...	..	...	.	...	...	.
Two-year-olds ..		..		20 5	18 15		18 5	15 0	13 0
Three-year-olds			.	23 5	20 10		22 15	19 10	...
DAIRY COWS—									
Ayrshire:									
In Milk ...	29 8	21 2	12 19	31 13	23 10	14 0	29 16	22 5	12 5
Calvers . ..	28 8	21 17	14 6	29 13	23 1	14 14	28 4	22 5	14 6
Shorthorn Cross:									
In Milk	35 14	27 5	17 8	34 12	26 9	19 4	33 11	25 0	18 10
Calvers . ..	33 0	25 2	16 16	31 2	23 4	16 15	30 18	22 15	16 14
SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs .	59 10	46 3	31 10	56 7	44 3	32 8	68 10	48 2	40 0
Half-bred Hoggs	72 1	59 7	47 11	72 8	60 2	46 8	65 7	54 0	40 4
Blackface Hoggs ..	38 5	29 4	24 10	39 1	31 11	27 0	40 0	33 9	32 7
Greyface Hoggs .	55 6	44 6	34 4	59 0	47 3	38 0	57 9	48 7	36 7
Down Cross Hoggs	60 6	53 11	...	64 0	52 8	47 6	72 0	59 0	..
PIGS—									
(6 to 10 weeks old)	56 8	39 10	...	58 5	39 5	...	58 0	37 8	...

AVERAGE PRICES OF DEAD MEAT AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters.*)

Description.	Quality.	March.			April.			May.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.
		per lb. d.	per lb. d.	per lb d.	per lb. d.	per lb d.	per lb d.	per lb. d.	per lb. d.	per lb. d.
BEEF :—										
Home-fed—										
Bullock or Heifer ...	1	9¼	9⅝	11¼	9	9½	11	8⅞	9⅝	11⅛
	2	8¾	8⅞	10	8¾	8¾	10	8½	...	10⅛
Bull	1	7½	7½	7⅛	7¼	7⅝	7⅞	7¼	7½	7⅝
	2	7	...	5⅞	6½	6½	6	6¾	...	6⅝
Cow	1	6¼	5⅝	6¾	6½	6	6⅞	6½	6¼	7⅛
	2	5¾	4¾	5½	6	5⅝	5¼	6	...	5⅝
Irish—										
Bullock or Heifer ...	1	...	..	9¾	...	...	9¾	...	...	...
	2	..	..	8¼	...	...	8½	...		...
Bull	1	..	. .	6⅛	...	...	6⅛	..	...	
	2	...		5½	...	..	5⅝	...	.	.
United States & Canadian—										
Killed at Birkenhead ..	1	..		8¾	.	...	8½		. .	.
	2	...	..	8	...	...	8	..	...	...
Killed at Glasgow ...	1	.	.	9¼	...	.	9¾	. .	..	9¼
	2	...	.	8¼	..	.	8½		..	8½
Argentine Frozen—										
Hind Quarters ..	1	..	5⅜	...	5¾	5½		6½	5⅞	...
	2	...		...	..	.		.	5½	...
Fore ,, ...	1	...	3¾	.	3¾	·3¾		4½	3⅞	.
	2	...	.	...	...		.		.	...
Argentine Chilled—										
Hind Quarters ...	1	6¼	6¼	6¼	6⅝	6¾	6¾	7¾	7⅝	7⅝
	2	5	5¾	5¾	...	6⅝	6⅝		. .	6⅞
Fore ,, ...	1	3½	3½	3½	3¾	3⅝	3⅝	4¾	4½	4⅝
	2	2¾	3¼	3¼	...	3¾			...	4⅛
New Zealand Frozen—										
Hind Quarters ...	1	..	...	5¼	...	.	5⅝		..	6
Fore ,, ...	1	...	...	3⅛	..	. .	3⅜		...	3⅝
MUTTON :—										
Hoggs, Blackface ...	under 60 lb.	12¼	12⅞	13¼	14	14¼	13¾	14⅛	14¼	14⅛
	60 lb. & over	11¼	11⅞	12¼	13⅜	13½	12⅞	13⅜	..	13½
,, Cross	under 60 lb	12¼	12⅞	12¾	14	14¼	13¼	14⅛	14¼	13⅞
	60 lb. & over	11¼	11⅞	12	13⅜	13½	12⅝	13⅜	...	13
Ewes, Cheviot	1	9¼	9⅝	10¼	11	10	10⅞	11	9⅛	12⅝
	2	8¼	...	9	10	...	9⅝	10	...	11½
,, Blackface ..	1	9¼	9⅝	10⅛	11	10	10¾	11	9⅛	12⅜
	2	8¼	...	9⅜	10	.	9⅝	10	..	11¼
,, Cross	1	7	8⅝	9	7½	9⅛	9¼	8¼	8½	11
	2	6		8½	6½	.	8⅝	7¼		10¼
Argentine Frozen ...	1	...	..	6½	..	...	6½	...	...	6½
	2		...	5½		...	5½			5¾
Australian ,, ...	1	...	5¾	...	..	6	. .	...	6¼	...
	2	...	5½	..		..	...	.	5½	...
LAMB :—										
Home-fed	1	...	...	...	..	...	..	17	18¼	...
	2	...	..	..	..	..	...	...	...	...
New Zealand Frozen ...	1	...	10⅜	10	...	11¾	10⅝	..	11⅝	10⅝
	2	...	...	9	...	11	9⅝	...	11¼	9¼

Average Prices of Provisions at Glasgow.

(Compiled from Reports received from the Board's Market Reporter.)

Description.	Quality.	March.	April.	May.
		s. d.	s. d.	s. d.
BUTTER:				
Argentine ... per cwt.	1	...	...	...
" (Unsalted) "	1	179 0	179 6	180 0
Australian ... ... "	1	177 2	178 0	178 6
Danish ... ... "	1	198 7	185 0	179 6
" (Unsalted) ... "	1	204 7	190 9	185 0
Friesland (Unsalted)... "	1	206 2	186 6	180 0
New Zealand ... ... "	1	179 7	181 3	179 0
" (Unsalted) "	1	182 2	183 3	181 0
Russian ... .. "	1	...	169 6	167 4
Swedish ... ... "	1	190 3	179 9	175 8
CHEESE:				
Cheddar (Old)... ... "	1	132 2	130 0	130 0
	2	116 10	110 0	...
" (New) ... "	1	...	99 0	92 6
	2	...	94 0	...
Cheddar Loaf (Old) ... "	1	138 5	124 6	120 0
	2	136 5	120 6	...
" (New) ... "	1	...	...	98 0
	2	...	...	...
Dunlop (Old) ... ... "	1	118 5	113 0	114 6
	2	107 5	104 0	...
" (New)... ... "	1	...	95 0	84 6
	2	...	90 0	...
Canadian ... ... "	1	114 10	115 0	115 3
New Zealand (Coloured) "	1	108 0	105 3	100 9
" (White) "	1	105 10	103 9	100 0
BACON:				
Ayrshire (Rolled) ... "	1	161 0	161 0	162 0
Irish (Green) ... ... "	1	154 10	158 6	160 0
" (Dried or Smoked) "	1	164 10	168 6	170 0
" (Long Clear) ... "	1	160 0	161 0	163 6
Wiltshire (Green) ... "	1	158 2	161 0	163 0
" (Dried or Smoked) "	1	168 2	170 6	173 0

Description.	Quality.	March.	April.	May.
		s. d.	s. d.	s. d.
BACON—*contd.*				
American, Long Clear Middles (Green) per cwt.	1	119 0	121 6	123 6
" Short Clear Backs "	1	116 7	117 0	119 3
" Sides ... ... "	1	105 0	105 9	108 6
" Cumberland Cut "	1	...	...	...
Canadian, Sides ... "	1	117 10	126 0	127 0
Danish, Sides ... ... "	1	128 5	138 3	142 0
HAMS:				
Irish (Smoked) per cwt.	1	200 0	212 0	222 0
	2	184 2	200 0	212 0
American, Long Cut (Green) ... ... "	1	117 5	121 0	128 0
American, Short Cut "	1	118 7	119 6	125 6
EGGS:				
Country ... per doz.	1	1 8	1 4	1 5
	2	1 6	1 2	1 3
Irish ... ... per 120	1	14 2	12 6	12 11
	2	13 5	11 8	12 4
" (Duck) ... "	1	15 3	13 2	12 11
	2	14 6	13 0	...
Belgian... ... "	1	12 10	11 10	12 1
Danish ... ... "	1	15 1	13 8	14 0
	2	13 10	12 1	12 7
Dutch ... ... "	1	12 10	11 10	12 1
" (Duck)... "	1	12 5	12 4	12 1
Egyptian ... "	1	9 10	7 11	...
	2	...	7 8	...
Polish ... ... "	1	10 8	9 1	9 3
	2	9 4	7 11	8 7
Swedish ... "	1	13 5	12 1	12 8

AVERAGE PRICES OF POTATOES AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

MARKET		Quality	Late Varieties. Red Soils: Langworthy and Golden Wonder	Red Soils: Other	Other Soils: Langworthy and Golden Wonder.	Other Soils: Other.
			£ s. d.	£ s. d.	£ s. d.	£ s. d.
MARCH.						
Dundee	per ton.	1			5 10 0	3 2 0
Edinburgh	,,	1			7 0 0	4 0 0
Glasgow	,,	1	8 0 0	6 0 0	6 13 0	3 13 0
APRIL.						
Dundee	,,	1			5 10 0	2 19 0
Edinburgh	,,	1			6 0 0	4 0 0
Glasgow	,,	1	7 14 0	6 0 0	6 5 0	3 11 0
MAY.						
Dundee	,,	1			5 0 0	3 1 0
Edinburgh	,,	1			7 0 0	4 13 0
Glasgow	,,	1	7 7 0	6 0 0	7 0 0	5 3 0

AVERAGE PRICES OF ROOTS, HAY, STRAW, AND MOSS LITTER, AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

MARKET		Quality	Roots: Carrots	Roots: Yellow Turnips.	Roots: Swedes.	Hay: Rye Grass and Clover	Hay: Timothy	Straw: Wheat	Straw: Barley	Straw: Oat	Moss Litter
			s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
MARCH.											
† Dundee	per ton	1	..	12 4	17 0	145 0 (a) 133 0 (b)		91 0	91 0	99 0	51 2
‡ Edinburgh	,,	1				137 6 (a) 130 6 (b)		86 0	75 0	90 0	39 0
‖ Glasgow	,,	1				106 0	111 0	75 0		85 0	37 6
APRIL.											
† Dundee	,,	1			16 9	143 9(a) 132 6(b)		87 6	87 6	92 6	51 0
‡ Edinburgh	,,	1				137 6(a) 132 6(b)		90 0	80 0	90 0	39 0
‖ Glasgow	,,	1	..			100 0	105 0	75 0		85 0	37 6
MAY.											
† Dundee	,,	1			21 5	145 0(a) 131 3(b)		88 9	88 9	93 9	51 0
‡ Edinburgh	,,	1				137 6(a) 135 0(b)	.	90 0	81 3	90 0	39 0
‖ Glasgow	,,	1				100 0	105 0	75 0		85 0	37 6

† Quotations for Straw, baled and delivered.
‡ ,, ,, delivered loose in town.
‖ ,, baled Hay and Straw f.o.r.

(a) Baled and delivered.
(b) Delivered loose.

Average Prices of First Quality Fruit and Vegetables at Glasgow.

(Compiled from Reports received from the Board's Market Reporter.)

Description.		March.	April.	May.
Fruit:—		s. d.	s. d.	s. d.
Apples, *Imported*:				
Californian ...	per case.*	13 3	12 10	14 0
Oregon	"	15 5	15 0	16 0
Other American ...	"	12 5	12 0	12 0
Australian ..	"	...	16 0	14 9
Pears, South African	per box **	...	5 0	...
Vegetables:—				
Asparagus	per bunch.	...	3 6	4 6
Beet	per cwt.	7 0	7 0	7 0
Cabbages—				
Coleworts... ...	per doz.	1 0	0 11	1 3
Savoys	"	2 4	...	...
Carrots	per cwt.	7 0	8 9	27 6
Cauliflowers—				
Broccoli, Cornish	per doz.	4 10	5 8	..
Other British ...	"	...	...	7 4
French	"	4 5	6 0	...
Celery	per bunch.	1 6	...	...
Cucumbers	per doz.	12 0	7 6	7 0
Greens	"	1 0	1 0	1 0
Leeks ...	per doz. bunches.	4 8	3 5	4 0
Lettuce, Cabbage ...	per doz	2 8	2 4	1 11
Onions—				
Spring	per bunch.	0 5¼	0 4¾	0 6
Dutch	per bag.‡	6 8	...	...
Egyptian ...	" §	14 0	10 11	13 0
Valencia	per case.†	9 11	...	...
Parsley	per cwt.	48 0	44 0	58 8
Parsnips	"	8 10	8 3	...
Radishes ...	per doz. bunches.	...	0 10	1 0
Rhubarb	per cwt.	26 10	8 6	9 3
Tomatoes—				
Canary	per lb.	0 6½	0 7	0 10
Channel Islands ...	"	0 9	2 6	1 5
Turnips	per cwt.	2 6	2 6	3 2

* 40 lb. (approx.). ** 7 lb. (approx.). † 9 stone (approx.).
‡ 7½ stone (approx.). § 8 stone (approx.).

AVERAGE PRICES OF FERTILISERS AT GLASGOW AND LEITH.

(Compiled from Reports received from the Board's Market Reporters.)

Description	Guaranteed Analysis	March Glasgow	March Leith	April Glasgow	April Leith	May Glasgow	May Leith
	%	per ton £ s d	per ton £ s d	per ton £ s d	per ton £ s d	per ton £ s d	per ton £ s d
Nitrate of Soda	N 15½	13 10 0	13 5 0	13 10 0	13 5 0	13 10 0	13 5 0
Nitrate of Lime	N 13	11 15 0		11 15 0		11 15 0	
Sulphate of Ammonia (Neutral and Granular)	N 21	12 18 10	13 1 0	13 1 0	13 1 0	13 1 0	13 1 0
Superphosphate	S P 30	3 2 6	3 2 6	3 2 6	3 2 6	3 2 6	3 2 6
"	S P 35	3 8 0	3 8 3	3 7 6	3 7 6	3 7 6	3 7 6
"	S P 38	3 12 6	3 14 0	3 12 6	3 12 6	3 12 6	3 12 6
Bone Meal Home	N 5, I P 40	8 4 0		8 0 0		8 0 0	
" " "	N 3½, I P 49		8 3 0		8 0 0		8 0 0
" " —Indian	N 3¾, I P 49		8 8 0		8 5 0		8 5 0
Steamed Bone Flour	N 1, I P 60	7 4 0	6 0 0	7 10 0	6 0 0	7 10 0	6 0 0
Basic Slag	I P 22	*2 4 6		*2 4 6		*2 4 6	
" "	" 24	*2 7 6		*2 7 6		*2 7 6	
" "	" 26	*2 11 6	**2 13 6	*2 11 6	**2 13 6	*2 11 6	**2 13 6
" "	" 28	*2 15 0	**2 15 0	*2 15 0	**2 15 0	*2 15 0	**2 15 0
" "	" 30	*3 0 0	**2 17 0	*3 0 0	**2 17 0	3 0 0	**2 17 0
" "	" 40		†3 2 0		†3 5 0		†3 5 0
Sulphate of Potash (on basis 90 per cent sulphate of potash)	Potash 48.6	10 2 6		10 2 6		10 2 6	
Sulphate of Potash	" 50		10 2 6		10 2 6		10 2 6
Muriate of Potash (on basis 80 per cent sulphate of potash)	" 50	8 5 6	8 0 6	8 5 6	8 0 6	8 5 6	8 0 6
Potash Salts	" 20	3 2 6	3 1 0	3 2 6	3 1 0	3 2 6	3 1 0
" "	" 30	4 8 0	4 8 0	4 8 0	4 8 0	4 8 0	4 8 0
Kainit—In bags	" 14	2 15 6	2 14 0	2 15 6	2 14 0	2 15 6	2 14 0
Ground Mineral Phosphate— Finely ground	I P 60	2 10 0		2 10 0		2 10 0	
North African	I P 56		2 5 0		2 5 0		2 5 0

Abbreviations —N = nitrogen, S P = soluble phosphate, I P = insoluble phosphate, T P = total phosphate

* Carriage paid (4 ton lots) to Ayrshire and Renfrewshire; quotations for delivery in Lanarkshire 2*s.* per ton higher

** English Slag, carriage paid to stations in the Lothians † Belgian Slag, at Leith

Average Prices of Feeding Stuffs at Glasgow and Leith.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	March.		April.		May.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	11 18 0	11 11 0	11 7 6	10 16 3	11 3 9	10 15 0
Foreign	11 18 0	...	11 4 5	...	11 4 5	...
Decorticated Cotton Cake	11 13 6	...	11 2 6	...	11 1 3	...
Undecorticated Cotton Cake—						
Bombay (Home-manufactured)...	7 0 0	6 1 0	..	5 12 6	...	5 18 9
Egyptian (Home-manufactured)...	6 17 6	...	6 10 0	...	6 9 5	...
Palmnut Kernel Cake	8 1 8	..	7 10 0	...	7 7 6	..
Coconut Cake ...	9 8 4	...	9 6 3	...		..
Groundnut Cake— Undecorticated	*8 0 0	...	*7 10 0	...	*7 11 3	..
	**8 8 0	**7 12 0	**7 16 11	**7 10 0	**7 17 6	*7 10 0
Maize Germ Cake—						
Home	10 1 0	..	9 10 0	...	9 12 6	...
Foreign	9 16 8	...	9 13 9	...	9 8 9	...
Maize Germ Cake Meal	10 0 0	...	9 11 3	...	9 13 2	...
Bean Meal	11 15 0	12 0 0	12 0 8	12 0 0	11 18 9	12 0 0
Maize Meal—						
Home Manufactured	9 4 6	...	9 8 9	...	9 10 0	...
South African Yellow	8 7 0	8 6 0	8 8 9	8 0 0	8 10 8	8 0 0
South African White	8 2 0	..	8 3 2	...	8 5 8	..
Rice Meal	7 0 6	.	6 11 11	...	6 13 9	.
Locust Bean Meal ...	9 7 6	8 15 0	9 5 0	8 15 0	9 0 0	8 15 0
Locust Beans (Kibbled and Stoned)	..	8 0 0	...	8 0 0	..	8 0 0
Maize Gluten Feed (Paisley) ...	8 17 0	...	8 10 8	...	8 8 2	...
Maize ...	†8 6 6	7 13 0	†8 13 9	7 10 0	†8 16 3	7 10 0
	‡8 3 0	...	‡8 6 3	...	‡8 10 0	...
Oats, Canadian— (No. 2 Feeds)	8 18 0	..	9 0 0	...	9 0 0	...
,, Plate	8 2 0	...	8 8 9	..	8 11 11	..
,, Home ...	9 7 0	8 18 0	10 8 4	9 5 0	10 12 6	9 17 6
Barley (Feeding) ...	8 19 6	8 2 0	8 16 8	8 7 6	..	8 15 0
Barley Bran ...	8 14 6	...	8 17 6	..	9 0 0	...
Malt Culms... ...	6 14 0	6 0 0	6 17 6	6 0 0	6 17 6	6 0 0
Distillery Mixed Grains—Dried	8 12 0	9 6 0	8 8 9	9 0 0	8 8 9	9 0 0
Brewers' Grains—Dried	8 15 0	8 5 0	7 16 8	8 5 0	7 11 3	8 5 0
Distillery Malt Grains—Dried .	8 8 6	...	8 0 0	...	7 13 9	...
Wheat—						
Middlings (Fine Thirds or Parings)	8 8 0	7 9 0	8 11 3	7 7 6	8 8 2	7 7 6
Sharps (Common Thirds) ..	6 14 0	7 1 0	6 14 5	7 0 0	6 13 2	7 0 0
Bran (Medium) ...	7 0 0	7 1 0	7 0 0	6 15 0	6 15 8	6 15 0
,, (Broad) ...	7 9 6	8 2 0	7 9 5	8 0 0	7 6 11	8 0 0
Feeding Treacle ..	6 18 0	7 0 0	6 15 0	7 0 0	6 15 0	7 0 0
Crushed Linseed ...	25 16 0	...	24 12 6	...	25 0 0	...
Fish Meal	19 16 0	18 5 0	20 0 0	18 5 0	19 10 0	18 5 0
Beans—						
China	11 0 0	...	11 0 0	...	11 2 6	...
English	11 11 0	...	11 8 9	...	12 0 0	...
Sicilian	10 19 0	...	10 18 9	...	11 2 6	...

* 37 per cent. Oil and Albuminoids.
** 40 per cent. Oil and Albuminoids.
† Plate.
‡ American, No. 2 Mixed.

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INSTITUTE FOR RESEARCH IN ANIMAL DISEASES.

IN the issue of this Journal for April 1925 some account was given of the origin in 1917 and the development of the Scottish Association for Research in Animal Diseases. Laboratory work at that time was being carried on in the premises of the Glasgow Veterinary College, but the accommodation was limited, and there were no facilities for the keeping of experimental animals under field conditions. Impressed with the necessity for improved conditions, the Directors of the Association considered several possible locations for their headquarters, and made urgent representations to the Government Departments concerned for grants towards the cost involved.

In March 1924 the Association were fortunate in purchasing on favourable terms about 35 acres of land at Moredun, Liberton, on the outskirts of Edinburgh, and application was made to the Board of Agriculture for Scotland and the Development Commission for funds to meet the cost of purchase and the necessary equipment. At the same time an arrangement was made with the Royal (Dick) Veterinary College for a suite of rooms to be made available for histological, serological and bacteriological laboratories, and for micrographical and photographical work.

A capital grant of £18,000 was obtained from Government funds, and an additional £1,000 was raised by the president of the Association, Mr. Falconer L. Wallace. The Association has thus been enabled to provide at Moredun buildings and equipment which along with the field accommodation will enable the staff to carry on their investigations under much better conditions than hitherto, and with the larger farm animals as well as with the ordinary small laboratory animals. These buildings were completed in the summer of the current year and the work was transferred from Glasgow to the new laboratories on the 1st of June.

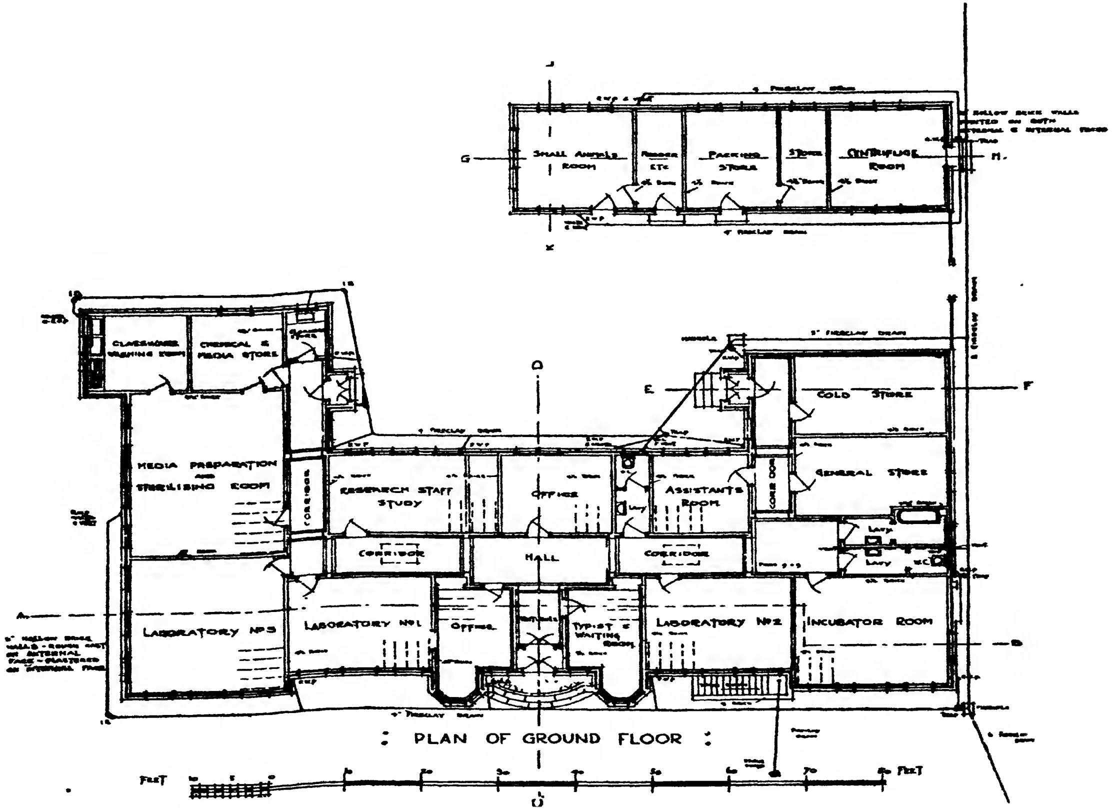
At Moredun the buildings are situated immediately to the west of the Edinburgh-Gilmerton road about three miles from the city. They are arranged in three blocks, with a caretaker's lodge and garage separately placed.

The main building includes four large and well-lighted laboratories with service rooms adjoining, two stores (one cold), library, and office accommodation for the Director, the Secretary and clerks.

Immediately behind the main building is the second block,

ANIMAL DISEASES RESEARCH ASSOCIATION.

FIELD LABORATORIES, ETC. AT LIBERTON.



consisting of rooms for small animals, a serum room, and a workshop.

Further south comes the stable block, with loose boxes for horses, cattle and sheep, arranged round a spacious courtyard. Two of the loose boxes on each side open not on to the courtyard but to the exterior, so that infectious cases may be isolated from other animals.

A well-appointed post-mortem room forms the south-western part of this block, while above the north-western side there is a large loft for fodder storage. A weighing machine for large animals is placed in the courtyard, and behind the block an incinerator has been provided.

Electric light and power, gas and water are laid on to each block from the Edinburgh Corporation supplies, and in the main buildings, as also in the serum room and the small animals room, a hot water supply and a central heating plant have been installed. The laboratories are furnished with incubators, sterilisers, centrifuges, microscopes, and all the apparatus necessary for modern pathological investigation.

The parks around the buildings are to be divided up by fences into seven paddocks of 2½ to 3 acres each, in order that different groups of experimental animals may be grazed separately and various field experiments may thus be carried out concurrently.

A special feature of the Institute will be the Library, in which it is hoped to make as complete as possible a collection of publications relating to animal diseases, and by a full system of indexing to make this readily available to the staff and to other scientific workers. Towards the foundation of the Library Mr. Falconer Wallace has made a gift of £500, and the Carnegie United Kingdom Trust have given £250 on condition that the books will be made available under certain conditions to members of the public who desire access to the literature of animal disease.

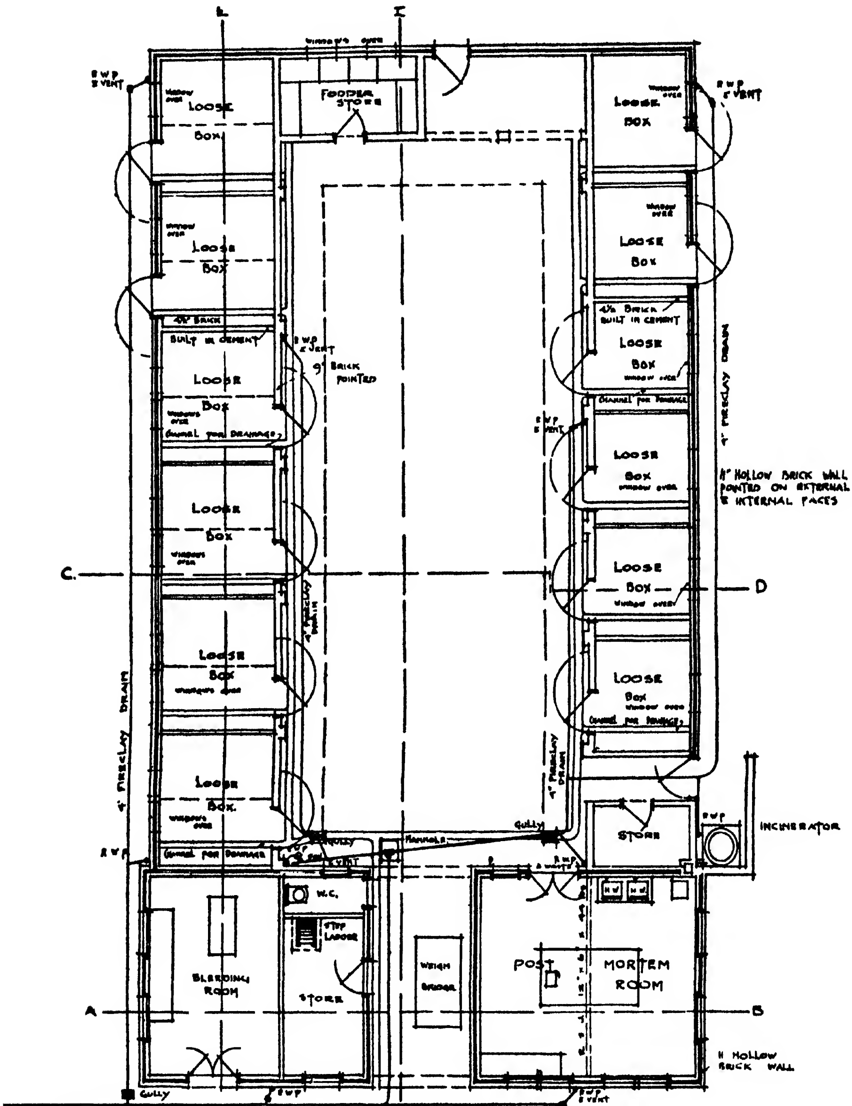
As already mentioned, in addition to the accommodation provided at Moredun, the rooms on the top floor of the Royal (Dick) Veterinary College are reserved for the work of the Association's scientific staff, and have been specially arranged and equipped for the more fundamental research, bacteriological and histological.

A further interesting addition to the resources of the Institute has recently been intimated in the provision by Mr. Falconer Wallace of a motor laboratory. The Association is specially indebted to their president for this munificent gift, as it completes in the most satisfactory way the equipment for dealing with an outbreak of disease in outlying parts of the country. It will enable the workers to undertake fairly elaborate investigations into diseases on the farms where they occur, where all the local conditions can be seen and studied and where the animals attacked may be under observation at all stages of the disease, thus avoiding difficulties that have greatly handicapped investigators in the past.

The staff of the Institute is not yet complete, there being at present only three scientific workers engaged, but it is hoped that

ANIMAL DISEASES RESEARCH ASSOCIATION.

STABLES, ETC.



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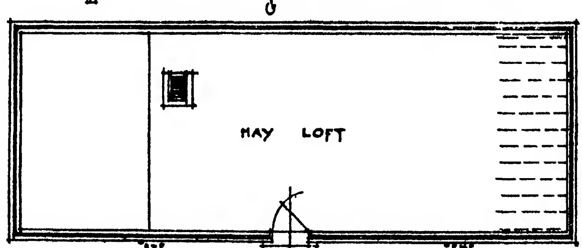

: PLAN OF UPPER FLOOR :

MAIN BUILDING FRONT VIEW

BACTERIOLOGICAL LABORATORY

LABORATORY WITH STERILISING PLANT

COURTYARD WITH LOOSE BOXES

ere long a full team of trained investigators will be at work, along with the necessary skilled assistants and attendants, while the laboratories will be open to post-graduate students specialising in animal pathology.

The investigations at present under weigh deal with dysentery of lambs, braxy, scrapie, louping-ill, and udder-clap of sheep; grass disease in horses; and mammitis, tuberculosis and contagious abortion in cattle. Reports on the progress of the work are published from time to time.

But there is a wide field of operation untouched. It is almost impossible to exaggerate the importance of this work to the stock-owners of the country. The most casual observer of the losses sustained by sheep farmers in any particular district must be impressed when he considers how tremendous the losses must be when multiplied over the whole country. A well-authenticated calculation of the extent of the yearly loss from the commoner sheep diseases in one county alone put it at over £14,000; and on the same basis the average yearly loss in Scotland would be over half a million, while if we include losses among cattle, horses, pigs and poultry, it is no exaggeration to say that the annual loss must be well over a million pounds.

If then research can discover the causes and prescribe the methods of control necessary to keep stock diseases in check, it is obvious that money spent upon the means of research will be returned to the community many times over. The Association is now in the position, thanks to Government aid and to support from a few generous donors, of having at last the means and equipment required for a sustained attack upon the problems of animal disease, but it is necessary to point out that an assured annual income is an essential condition of the satisfactory continuance of the work, and all stock-owners can help in securing this by becoming, and remaining, members of the Association.

THE PROPORTION OF WATER IN MILK.

J. F. TOCHER, D.Sc., F.I.C.

(1) **The Regulations and the Public Analyst's Duty.**—The proportion of water in milk is an important problem from the point of view of the consumer as well as from the point of view of the milk producer. Ever since the Board of Agriculture in the year 1901 introduced regulations with respect to the proportions of butter fat and solids-not-fat in milk the question as to whether or not water has been added to genuine sweet milk has been repeatedly discussed in Courts of Law. Usually the evidence led is based upon the presumption raised against the seller—a presumption which arises from the regulations above referred to.

The oft-quoted regulations are as follows:—

1. Where a sample of milk (not being milk sold as

skimmed, or separated, or condensed milk) contains less than 3 per cent. of milk fat, it shall be presumed for the purposes of the Sale of Food and Drugs Acts, 1875 to 1899, until the contrary is proved, that the milk is not genuine, by reason of the abstraction therefrom of milk fat, or the addition thereto of water.

2. Where a sample of milk (not being milk sold as skimmed, or separated, or condensed milk) contains less than 8·5 per cent. of milk-solids other than milk fat, it shall be presumed for the purposes of the Sale of Food and Drugs Acts, 1875 to 1899, until the contrary is proved, that the milk is not genuine, by reason of the abstraction therefrom of milk-solids other than milk fat, or the addition thereto of water.

The duty of a public analyst under the regulations is to state on a certificate the proportion of butter fat and solids-not-fat found by analysis and compare the result with the presumptive standards of 3 per cent. butter fat and 8·5 per cent. solids not fat. As I have frequently pointed out, these presumptive limits are neither average values nor observed minimum values for butter fat or solids-not-fat, but arbitrary figures chosen by the Board. Thus milk sold to the public, containing less than 3 per cent. butter fat and 8·5 per cent. solids not-fat, may be genuine milk, but owing to the regulations a presumption is raised against the seller that the milk is adulterated until the seller by his evidence in a Court of Law establishes the fact that the milk has not been tampered with and is really genuine milk. Great confusion arises in the minds of many in cases where a public analyst states his opinion that the milk has been adulterated *by the addition of water.* Such a statement is not required from the analyst at all. All he is required to do under the Regulations is to state his results and their bearing on the presumptive limits of the Board. If, for example, a milk contained 2·8 per cent. of butter fat, he can state in his certificate that the milk is below the prescribed presumptive limit to the extent of 0·2 per cent. Genuine milk varies in the proportions of water it contains and on that account it is not in the power of science to state categorically that water to the extent of say 5 per cent. or more has been added to milk without a previous knowledge of the composition of the particular sample. In other words, before a public analyst could state that a sample of milk from say farm A has been watered he would require to have analysed the sample as it came from the cow, prior to any opportunity for watering, before he could assert that the milk was adulterated. What the analyst actually does *in cases where he reports adulteration by water*, may be best seen by giving a numerical example. Suppose the milk contained 2·85 per cent. of butter fat. This is ·15 per cent. below the prescribed presumptive limit for butter fat. If the milk contained no butter fat at all, it would be 3 per cent. below the prescribed presumptive limit and would therefore be 100 per cent. deficient in fat compared with that limit. He reckons a deficiency of ·15 in 3 per cent. butter fat in milk as a deficiency of 5 per cent. of fat below the presumptive limit of 3 per cent. He then assumes

that water has brought about the deficiency. In other words he shows if milk always contained 3 per cent. butter fat, what amount of water would require to be added to bring the butter fat down to 2·85.

This is all very well if milk was constant in composition with respect to butter fat, but then we know it is not. Then take the case of a deficiency in solids-not-fat. Suppose 8 per cent. solids-not-fat were found in a sample. This is a deficiency of ·5 on 8·5 per cent. Thus if milk always contained 8·5 per cent. solids-not-fat, this sample would show an addition of nearly 6 per cent. of water. But milk is not constant with respect to its solids-not-fat content any more than it is constant in its butter fat content. Hence it is undesirable and misleading on the part of any analyst to state his opinion as to the addition of small quantities of water in milk. It is even undesirable that he should state what amount of water would be required to be added to milk containing 3 per cent. butter fat and 8·5 per cent. solids-not-fat to bring it down to the poor quality exhibited by the sample, poor in butter fat and solids-not-fat. The evidence of watering or tampering with milk on the part of the dairyman should be obtained directly. In other words the evidence should be obtained from the witnesses handling the milk. The proper role of the analyst is to state the results of analysis and leave the local authorities to satisfy themselves as to the genuineness or non-genuineness of the milk by bringing the dairyman and his employees into Court under the regulations, which they as local authorities are entitled to do.

(2) **Water in the Milk of Individual Cows.**—The Interdepartmental Committee which was appointed by the Secretary for Scotland in 1920 to consider and report on the laws, regulations and procedure governing the sale of milk in Scotland recommended an absolute limit for milk sold to the public; that is to say, if 3 per cent. was adopted as a legal limit for butter fat, then it would be an offence for a dairyman to sell milk containing less than 3 per cent. of butter fat. He would have to see, by proper selection of cows, bulking from a herd and testing the bulked milk, that the milk contained 3 per cent. of butter fat or above it. The procedure to be adopted, if a legal minimum limit were adopted for butter fat, is stated in the Interdepartmental Committee's report. Other proposals have been advanced from time to time to ensure that milk of good quality is supplied to the public and to detect fraud. All the plans are open to criticism, but it is clear that a discrimination must be made between the bulked milk of a herd of cows and the milk of one cow or the mixed milk of small herds. I propose in this short note to show the extent to which water varies in milk where individual cows are concerned and how the variation becomes less, as the number of cows whose milk is bulked is increased. I have shown[1] that the water in milk from individual cows taken from all over Scotland varies from 82 per cent. to 90 per cent. The following table (Table I) shows the frequency distribution of the percentage of water in 676 cases.

[1] "Variations in the Composition of Milk," H.M. Stationery Office, 120 George Street, Edinburgh.

TABLE I.

Per cent. Water. From	To	*Number of Cases.*
82·01	82·50	1
82·51	83·00	1
83·01	83·50	2
83·51	84·00	2
84·01	84·50	6
84·51	85·00	9
85·01	85·50	11
85·51	86·00	34
86·01	86·50	70
86·51	87·00	121
87·01	87·50	147
87·51	88·00	139
88·01	88·50	89
88·51	89·00	26
89·01	89·50	14
89·51	90·00	3
		676

It should be clearly kept in mind that these proportions are the proportions of water found in samples of milk taken from individual cows and not from the bulked milk of a herd. The proportions of water in the bulked milk of a herd will be discussed further on. In order to see clearly the relation of water to other constituents in the case of individual cows the figures in the accompanying table (Table II) should be studied. The figures are the average percentages for the named constituents.

TABLE II.

Constituent.	*Average Percentage.*
Butter Fat	3·95
Lactose	4·64
Casein	2·43
Albumen	0·74
Other nitrogenous substances ...	0·35
Ash	0·70
Water	87·19
	100·00

While water is present on an average to the extent of 87 per cent. it is, relatively speaking, much less variable in its proportions than other constituents of milk in samples from individual cows, as may be seen from the following table (Table III).

TABLE III.

Constituent.	*Relative Variability.*
Water	1·00
Ash	6·27
Lactose	6·97
Casein	11·90
Butter Fat	17·18
Albumen	17·39

This table shows the relative variabilities of the constituents compared with the variability of water as 1 per cent. The figures show the number of times each constituent is more variable than water is in milk from individual cows and clearly establish that water is by far the least variable constituent in milk. For example, ash in milk is six and a quarter times more variable than the water in milk. Butter fat is 17 times more variable than water in milk.

(3) **Water in the Mixed Milk of Random Herds.**—I have shown that milk from the individual cow may vary from 82 to about 90 per cent. If milk, however, is bulked, this bulking has the effect of reducing the range of variation. And the reason for this observed fact is easily seen. When the milk of individual cows is bulked, the effect of a low percentage say of fat from one cow is counterbalanced by a higher percentage from another cow. The result is that an *average* is obtained from a herd for butter fat. The same argument holds for all constituents. We are led therefore to consider how averages of the constituents vary for herds of the same size. Let us select as an example herds of 5 cows and in order to eliminate the effect of any special selection for quality or quantity, let us draw samples of milk at random both for quality and for quantity.[1] We can now observe how the percentage of water varies in herds of any given size, selection having been eliminated. The undernoted table (Table IV) shows how the percentage of water varied in a thousand random herds of 5 cows.

TABLE IV.

Percentage Water.	*Number per* 1000.
84·88	1
85·13	0
85·38	1
85·63	4
85·88	12
86·13	34
86·38	67
86·63	104
86·88	141
87·13	204
87·38	207
87·63	122
87·88	72
88·13	27
88·38	4
	1000

The percentage of water varied from 84·88 to 88·38 per cent. Compare these figures with the percentages of water found from one cow, namely from 82 to 90 per cent. The range of

[1] The quality and quantity of milk of each cow were quite unknown to the sampler. The cows were given a number and the numbers were picked at random—every third or fourth number being taken.

variation is reduced from 8 to 2·5 per cent. In random herds of 10 cows the percentage of water was found to vary from 85·8 to 88·1 per cent., a range of variation of 2·3 per cent. In random herds of 20 cows the range of variation is about 1·5 per cent. We thus see that in random herds, the range of variation depends upon the number of cows whose milk is bulked. In practice it is often very difficult to state the number of cows whose milk is bulked for sale. We have the further difficulty from the point of view of probable watering of milk, of the dairy herds being more or less selected. In other words these herds cannot be regarded as being randomly selected for quality and quantity. Suppose in any particular case it was known, prior to adulteration with water, that a sample of milk contained 13 per cent. of total solids and 87 per cent. of water. Consider the effect of adulterating with water to the extent of 4 per cent. That is to say, suppose we take 96 parts of the milk and 4 parts of water and mix them. We now have 100 parts of adulterated milk. What is the total percentage of water present in the adulterated milk? The answer is 87·52 per cent. or the half of one per cent. more water than was present in the original genuine milk. Take another case. Suppose 90 parts of milk, containing 13 per cent. of total solids, were mixed with 10 parts of water, giving 100 parts of adulterated milk. What is the total percentage of water present? The answer is 88·3 per cent. or 1·3 per cent. more water than was present in the original milk. Thus it is seen that, *when the milk is actually known to contain* 87 *per cent. of water*, an addition of 4 per cent. water increases the total water from 87·0 to only 87·5, and an addition of 10 per cent. water increases the total water from 87·0 to 88·3 per cent. an increase of only 1·3 per cent. But we never know the original water percentage of samples in cases brought before the Court. Further we have just seen that in herds of 10 cows the range of variation of the water percentage in random herds is at least 2·3 per cent. In selected herds of 10, the range may be smaller but is quite unknown and in certain cases, owing to the operation of seasonal and other factors, the range of variation may be considerably over 2·3. Thus it is quite impossible for the public analyst to state, *from the results of his analysis and from his experience of milk analysis*, whether milk has been watered or not. Nor can he say whether or not milk has probably been watered unless he knows the number in the herd and unless he has also had previous knowledge of the milk of the herd from day to day. My experience of adulteration of milk and of milk the genuineness of which is doubtful is that either skimmed milk has been added or butter fat extracted from the genuine product. The range and nature of variation in butter fat are both involved in discussing these forms of breaches of the law, and will form the subject of a further note on milk.

AGRICULTURAL RESEARCH IN THE BRITISH EMPIRE.

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II. AGRICULTURAL RESEARCH IN CANADA.

IN the first article of this series the importance of the development of agriculture within the Empire was discussed. It was pointed out that in many cases successful development is dependent on the solution of problems arising in the course of the development. Reference was made to the facilities now provided by the Civil Research Committee of the Cabinet and the Empire Marketing Board for the promotion and organisation of investigations likely to lead to the solution of these problems. It is now being recognised that many problems of Empire importance can best be attacked by the combined effort of several organisations operating in different parts of the Empire. When all the information on the subject is pooled and the available sources for further research organised, the chances of obtaining results of immediate economic importance are enormously increased. There are within the Empire a great many research institutions and organisations each carrying on several lines of investigation. In many cases somewhat similar work is being done in widely separated parts, and there is too little inter-communication between workers engaged in similar investigations, but working under different organisations and separated by long distances. In the last article an account was given of the veterinary research work in South Africa, and it was shown that some of the results being obtained there in connection with the mineral content of pastures could be correlated with results being obtained in similar investigations in other parts of the Empire. It is interesting to note here that arrangements have now been made by a Sub-Committee of the Civil Research Committee and the Research Committee of the Empire Marketing Board to extend the scope of these investigations on the mineral content of pastures, and to link up the new work now being undertaken with the work which has been going on for some years in Britain, South Africa and elsewhere. At the same time as the work is being better organised and extended, all the information which can be gathered from the literature or obtained from those already working on the subject is being collected and put in such a form that it will be easily available for research workers or others interested in any part of the Empire.

In the present article a short account is given of research activities in Canada, where there has been developed a research organisation suited to that country with its wide range of climate and diversity of soils. Canada is a land of great agricultural wealth which is still rapidly developing. The estimated revenue from agriculture for 1924 was nearly $1,453,368,000, i.e. nearly £300,000,000. This was an increase on the previous year of about

$142,782,000. The growth of this wealth and its volume is due in a large measure to the early recognition of the value and importance of agricultural research and education, and the facilities for these which in consequence have been provided from time to time.

Development and Organisation of Research in Canada.—Agricultural research and education in Canada dates back to 1873 when the Guelph College, referred to below, was established. Nothing further was done until 1884, when, as a result of the depression in agriculture which then prevailed, the House of Commons appointed a Select Committee to enquire into the agricultural conditions in Canada. The Committee reported that the depression was mainly due to "ignorance of good farming methods, leading inevitably to soil impoverishment, poor crop returns, consequent discontent and frequent abandonment of the land and emigration to other countries." The Committee recommended that agricultural experimental and demonstration work should be undertaken and a vote was passed for this purpose.

Dr. William Saunders, the eminent chemist, horticulturist and entomologist, who held a Chair in the North West University at London, Ont., was commissioned to enquire and report on the best method of carrying out the proposed scheme of experimental work. He recommended the establishment of a Central Experimental Farm near Ottawa and several branch experimental stations in different parts of the country. Dr. Saunders was chosen to carry out the scheme and was appointed the first Director of the Dominion Experimental Farm System. During the next few years the Central Station and a number of the branch stations were established, and as the work expanded a number of special officers were appointed to supervise various lines of investigation.

In 1911 Dr. Saunders was succeeded by Dr. J. H. Grisdale, who had the heavy task of getting the work under way at the new stations which had been acquired in the preceding few years. During his tenure of office the continued expansion of the work necessitated the appointment of further highly trained specialists to deal with the various new lines of enquiry which had to be undertaken.

In 1916 Dr. Grisdale was appointed Deputy Minister of the Department of Agriculture, and was succeeded as Director of the Experimental Farms by Mr. E. S. Archibald, who has pursued a policy involving both the expansion of the work and the closer co-ordination of the various investigations.

The organisation now consists of a Central Research Station and 24 Experimental Farms situated in different parts of the country. In addition to these stations, where the research and experimental work is carried on, there are 145 Illustration Stations, where outstanding results of experimental work are demonstrated on farms owned and operated by individual farmers. The Director, who is the general administrative officer, is responsible for the control and co-ordination of the research work both at the Central Station and the Experimental Farms. He is assisted in the organisation and supervision by Heads of Divisions who are

specialists in some branch of agricultural science or practice. Each of these supervises, under the general control of the Director, his special line of investigation at the Central Station and also on the Experimental Farms. This arrangement secures the necessary co-ordination of research effort throughout the Dominion. The offices of the Director and these Dominion Specialists and the Central Experimental Station are situated at Ottawa, which is thus the headquarters of the system.

This organisation, with the Central Research Station and Central Offices at Ottawa and a number of Experimental Farms and Illustration Stations located in different parts of the country, is well suited to the needs of Canada with its great expanse of territory, within which are widely different climatic conditions, different soils and different types of agriculture. It has always been recognised by the Directors that the results of research do not become of practical value to the farmer in any particular area until they have been tested and demonstrated under practical conditions in that area. The large number of experimental farms and illustration stations enables this to be done, and ensures that experimental results are brought immediately to the notice of the farmers in the different districts and applied under the conditions prevailing in these districts.

The total vote for these experimental farms and stations amounts to $1,400,000, but there is a gross revenue of about $300,000 from the sale of animals and produce. Part of this money is devoted to administrative and educational work of one kind or another. Approximately $940,000 is expended on research and experimental work. The technical and clerical staff number about 300.

In addition to the work carried on by the Dominion Government Organisation, a good deal of research work is being done at Colleges of Agriculture or Agricultural Departments attached to Universities. These institutions are under the jurisdiction of their respective provincial governments, who make the necessary grants for the research work carried out by them. Two of these colleges are of special interest. Guelph College, which is now affiliated with the University of Toronto, was the first College of Agriculture in Canada, and for several years was the only place where any agricultural experimental or educational work was done. The M'Donald College, which is incorporated with M'Gill University, is due to the generosity of the late Sir William C. M'Donald, who devoted the princely sum of £2,000,000 to the establishment and endowment of the College.

At first sight it might appear that there would be a certain amount of unnecessary duplication of effort in the Dominion Experimental Farms and the Provincial Colleges. As a matter of fact there is close co-operation among all the Experimental Stations, and the multiplicity of problems involved in exploring the agricultural possibilities of the different provinces provides more work than can be undertaken even by such a large number of organisations.

In certain investigations it may be necessary to secure the co-operation of science faculties of Universities or of other scientific

organisations in addition to the agricultural research stations and colleges. Provision for this co-operation is secured through the National Research Council, which was constituted in June 1916 as a Sub-Committee of the Privy Council. The terms of reference to this Council embraces both industrial and agricultural research, and one of its main functions is to link up and co-ordinate as far as possible all the research work throughout the Dominion, and to consult and advise concerning where specific researches might be undertaken to the best advantage. The Council is able to utilise the best available equipment and concentrate the best brains on problems, the solution of which is likely to lead to further economic developments. An example of the work of this Council in pooling all the resources for a concentrated attack on an agricultural problem is found in the work at present being done in connection with the prevention of rust in wheat, to which reference is made later.

Nature of Research Work.—It is obviously impossible in a short article such as this to give an adequate account even of the main lines of the investigation being carried out in Canada. A few notes on some of the investigations which are of great practical interest will, however, be sufficient to give an idea of the great economic importance of the work being carried out.

Wheat Breeding.—Canada is now the third largest wheat-producing country in the world. This achievement is directly due to the experimental work in wheat breeding carried out at the Experimental Stations. Up to the end of last century certain strains of wheat such as "Red Fife" and "Huron" were grown successfully in the Eastern Provinces. But the shorter growing period and the early frosts of the North and West prevented successful wheat production in these vast regions. Dr. Saunders and his associates by breeding and selection produced a strain which ripens about a week earlier than the "Red Fife," and which has a strong straw and a non-shattering head, which are obviously valuable characteristics for the great wind-swept plains. This strain, known as "Marquis" wheat, made wheat growing possible for the whole of the Western Provinces, and considerably extended the Northern limits of successful wheat production. To-day it is estimated that 95 per cent. of Canada's wheat areas is in these prairie provinces. It is very interesting to note that 90 per cent. of the total wheat yield of the Western Provinces is developed from the single seed of "Marquis" wheat discovered in 1903. It is estimated that the "Marquis" wheat has increased the earning power of Canadian farmers by at least $20,000,000 per annum.

Further developments in wheat breeding have recently produced other varieties. One of the most interesting of these is "Garnet," which is even superior to "Marquis" in quality. Owing to the still earlier ripening and rust-resisting characteristics of "Garnet" wheat it is believed that the wheat belt will be extended a hundred miles further north.

These spectacular successes of the research organisation have obviously been of enormous importance in the agricultural developments of Canada. Indeed the extension of the wheat-growing area, which these discoveries made possible, is of importance to

the food supply of the whole world. At the recent meetings of the British Association, Sir Daniel Hall was predicting a shortage in the world's food supply owing to the rapid increase in population and the restricted area of the world's surface capable of producing wheat. Not only Canada but the whole world is indebted to Dr. Saunders and other officials of the Dominion Experimental Stations for their work on wheat breeding.

In dealing with wheat mention may be made of an investigation at present going on on cereal grain rust. It is estimated that since 1916 wheat rust caused a loss in Canada amounting to 250 million dollars. A concentrated attack organised by the National Research Council is now being made on this problem.

Tobacco.—In 1905 the then Minister of Agriculture appointed an expert to study methods of growing, curing and handling tobacco. The success of the work warranted its expansion, until in 1912 tobacco growing and curing was made one of the fourteen main divisions of the Experimental Farm System.

Selective breeding has produced strains of tobacco which can be grown successfully in Ontario and Quebec, and research has been carried out successfully on problems relating to soil, breeding, acclimatisation of seed, growing and curing. The results of these investigations have made possible the development of the tobacco industry in Canada. Within the last few years production has been increased 500 per cent. Canada now produces about four-fifths of the tobacco consumed in the Dominion and there is a growing export trade.

Forage Crops.—The plant breeding work on forage crops is almost as important as that on wheat and tobacco, because, if Canada is to take its place among the great live-stock producing countries in the world, forage crops must be grown in abundance. A large number of varieties of grasses and legumes are being tested at the different experimental stations for their yield, hardiness and general suitability for the different climatic and soil conditions in the various provinces. The extent to which this work is being pursued is shown by the number of strains isolated. There are 162 different strains of Ryegrass and 90 different strains of Alfalfa which have been isolated and are now under test at one or more of the experimental stations.

An important part of this work on forage crops is that relating to plants suitable for ensilage. A few years ago it was considered that certain districts in the Western Prairies could not produce suitable silage crops. By the introduction of the sunflower and breeding of several varieties of maize it has been found possible to produce in these districts heavy yielding crops suitable for silage. Silos are now being erected in these areas and are likely to become common. The successful production of silage is making the live-stock and dairy industries more profitable and encouraging their development.

Breaking in New Land.—There are in Canada great tracts of potentially fertile lands not yet fully cultivated, such as the vast area which was opened up by the trans-continental railway from Quebec to Winnipeg. In some cases drainage, in others irrigation, and in others clearing is required before the fertility of the land

can be made available. Investigations are being carried out to determine the best methods of carrying out the necessary operations required for the breaking in of these uncultivated areas. The results of these investigations are of great value to the settlers, who get the benefit of the accumulated experience of the officials engaged in this experimental work. For the colonists they are indeed "the friend who has gone before."

Animal Husbandry.—A good deal of practical experimental work has been done in the breeding and feeding of cattle, sheep and pigs. Of widest interest is the more recent work in connection with malnutrition caused by deficiencies of one or more "minerals" in the ration. It has been clearly demonstrated that the feeding of the pregnant dam is an important factor in determining the health and virility of the young. Of the many tests carried out with "mineral feeds" none is more striking than those in which potassium iodide was fed. It seems that the feeding of this mineral salt to mares during pregnancy is, to some extent, a preventive of joint-ill in foals.

Formerly heavy losses were sustained from the phenomenon of litters of hairless pigs. The young were born without hair, were sometimes not fully developed, and were usually feeble. This is now prevented by the feeding of potassium iodide to the sow. Beneficial results with iodine feeding have also been obtained with cattle and sheep. It seems probable that there are districts in Canada where the iodine content of the herbage is below the requirement of the animals grazing it. These investigations on the effects of deficiencies of lime, iodine and other minerals either in the soil or in the feeding stuffs are yielding results which are both interesting to the scientist and profitable to the stock farmer.

Poultry.—The poultry division is carrying on important research work in connection with incubation, rearing and handling. It is estimated that one hundred million eggs are wasted in Canada each spring because they fail to hatch, and that ten million chicks are lost each year owing to faulty methods of breeding or feeding. Intensive work on this subject is being carried out. Poor producing strains are being eliminated, better methods of incubation are being devised, and the results of recent research in nutrition are being applied to the better balancing of rations. It is expected that valuable information will be available in the near future to those interested in this branch of farming, which is one of considerable economic importance to the Dominion.

Empire Interest in Canadian Research Work.—Britain has a practical interest in the development of agriculture in Canada. The Dominion is one of the chief sources of our food supply, and one of the best customers for our goods. Further, the settlers who are bringing the great fertile tracts of land in Canada under cultivation are our own kith and kin. Apart altogether, however, from these considerations, the research work being done in Canada warrants even more attention than it receives from research workers in other parts of the Empire. The results being obtained in the Dominion Stations and Provincial Colleges have a direct bearing on work being carried out both in Britain and in the other

Dominions and Colonies. Thus, for example, Canada in studying the serious problem of "wheat rust" is obtaining information of potential value to all wheat growing countries. Of equal universal interest is her work on animal husbandry. The feeding tests with various mineral mixtures are essentially of the same nature as those being carried out in Britain, South Africa, Australia and New Zealand, and the results are comparable. In some cases, as for example in the investigation with iodine, the work in Canada is complementary to work being done elsewhere. At Aberdeen for the last three or four years laboratory researches on iodine metabolism have been throwing light on the iodine requirements of animals and the influence of iodine on metabolism, while in Canada, as has been noted above, practical tests are being made to determine the effects of feeding iodine to farm stock. Again the results of the work on tobacco growing and curing in Ontario and Quebec, where this industry has developed so rapidly during the past twenty years, are of value to Rhodesia, which is now rapidly extending her tobacco crop. Examples of points of contact and common interest in the research work of Canada and that of other parts of the Empire could be pointed out in connection with practically all the chief subjects of agricultural research.

It is of interest to compare the nature of the work in Canada with that in Britain. In every new district opened up in Canada there are new problems connected with the preparation of the soils for cultivation, soil fertility, the suitability of crops and so on. In the present rapidly developing stage, every effort must be made to solve these practical problems as quickly as possible. Hence research work in Canada on the whole is more immediately directed towards the solution of urgent practical problems than is the case in this country, where there is a long tradition of good farming and the soil has been under cultivation for generations. The changes of agricultural methods at home here proceed slowly, and a larger proportion of the research effort is directed towards the study of the fundamental principles of the sciences related to agriculture. But the ultimate end is the same in both cases. Indeed, the fundamental work and the practical work are frequently merely different parts of the same general problem. It is just possible that there is too little inter-communication between the two types of research work. There is, it is true, an exchange of publications, and facilities exist for meetings at International Congresses and other scientific gatherings. But publications usually deal with work which is more or less completed, and Congress meetings, though of very great value in bringing research workers together, are much too short to allow a full exchange of ideas with mutual criticism and suggestions.

We have long been accustomed sending research workers to the Continent and to the United States. It would be more profitable in many cases to arrange for exchanges not only of research students, but of senior workers between this country and Dominions such as Canada. The "academic" research worker who has been working at some fundamental problem would develop a much wider view if put for a period of six months or longer to an experimental station, where the practical application of the results

of his scientific studies were being tested, and on the other hand the work of the practical experimenter would be even more fruitful if he had, periodically, a few months' close association and work with men engaged in the fundamental aspects of his problem. It would be easy to select investigations common to both this country and Canada in which a temporary exchange of workers would be beneficial not only to the workers, but to the institutions with which they are connected. Useful work is already being done in correlating research effort and in pooling all the available information on certain problems. It would be almost equally valuable work to bring about this cross-fertilisation of ideas of both workers and institutions by arranging for a more frequent exchange of workers between the agricultural Research Institutions of this country and those of Canada.

Note.—The authors desire to acknowledge the assistance and advice of Mr. E. S. Archibald, Director of the Canadian Experimental Farms, in the preparation of this paper.

FARM BOOKKEEPING.

CASH ANALYSIS SYSTEM.

ARTHUR R. M'DOUGAL.

NO class of the community receives more free advice from well-meaning outsiders than the farmer, and on no subject has he received more advice, good and bad, than on that of farm bookkeeping. A few notes from a practical farmer may, therefore, be of some interest.

In the first place the objective aimed at should be clearly defined.

In some systems this objective seems to be merely the keeping of a correct cash account in a very complicated manner. This is the lawyer's system and suits him all right, as all that he requires in his capacity as an administrator of a trust or such like is that he should have a correct record of his cash transactions, and that his cash in hand balance should always be correct. He generally knows little about the details of the business, and whilst the data for ascertaining these are all included in the books, to find an answer to any simple detail of the business necessitates a laborious search.

To complicate matters further any account paid by a cheque has not only that payment recorded, but the bank transaction involved is also recorded in the receipts column. All the cash book entries are re-entered in the ledger, and the totals are not readily available until the annual balance is made, and then they are for the year only.

There is also the complete costings system, which is too intricate for the average farmer, and is perhaps also not too much to be relied upon, except in special circumstances.

Now the proper objects of the average farmer in keeping books should be—

A. To be able at a glance to tell at any time his receipts

and expenditure in any of the main sections of his business, clear of all complications, as well as his annual profit or loss.

B. To adopt as simple a system as possible, and to have no need of entering any transaction more than once.

No system that the writer has seen or tried fulfils these conditions so well as the cash analysis system. Though it is already used by many farmers it is still not widely known.

To work it the following books are needed :—

1. Cash analysis account book.
2. Bank pass book, supplied free by the bank and kept entered up to date by it.
3. Duplicate book for wages, called the wages book.
4. Duplicate book for goods sold if needed, called an invoice book.

The Cash Analysis Book (1) above is usually an oblong book about 17 in. long by 11 in. high, with an expenditure page and a receipts page opposite each other, with many columns suitably ruled and headed.

Herewith is given an example of one specially designed for a mixed arable and sheep farm with three hirsels of sheep, which with altered headings would suit any system of farming.

The example given has sample entries to illustrate the working of the system.

In entering a transaction in the expenditure page the section heading is first entered, then the name of the person dealt with, and the nature of the transaction.

The cash is written twice, once in the sectional column and once under "Total." In the example shown the entries of cash to the left of the black line are for information only, and not to be added to the totals on the right of the black line.

For instance, in an account containing various items a new tyre would be entered along with the rest in the merchants' column, but for information the tyre cost would be entered under "Car" also.

This farmer kept this record of car expenses as he wanted to know exactly what his car was costing him, and this seemed the easiest way to do it.

This is a very useful spare column to have, as in another year some other single item might be singled out instead of the "Car" and its expenses put in that column.

On the receipts page the same system is followed, and the columns to the left of the black lines are for information as to numbers of sheep sold off particular hirsels, with the spare cash column used to single out the wool and skins.

Every farmer would, of course, adapt these headings to suit his own ideas and system of farming so as to give him up-to-date the information he wished at a glance.

For instance the number of quarters or cwts. of grain, tons of potatoes, gallons of milk, cattle, &c., could be entered in these as desired.

The main headings of sections would, of course, be altered to suit individual needs, as it is impossible to devise a ready-made system of headings to suit everybody.

RECEIPTS 1926-27.

Date.	Section.	RECEIVED FROM.	Details. Gairmuir. Sheep.	Details. Gairmuir. Lambs. B.F.	Details. Scawert. Sheep.	Details. Scawert. Lambs. X.	Details. Scawert. Lambs. B.F.	Details. Field. Sheep.	Details. Field. Lambs. X.	Details. Field. Lambs. H.B.	Wool and Skins. £ s. d.	Sheep. Gair-muir. £ s. d.	Sheep. Scawert. £ s. d.	Sheep. Field. £ s. d.	Cattle. £ s. d.	Horses. £ s. d.	Crop. £ s. d.	Sundry. £ s. d.	Total. £ s. d.	Remarks.
		Brought forward	5	50	..	50	..	10	180	90	..	85 1 6	98 4 0	702 2 4	312 10 6	60 0 0	..	..	1257 18 4	
Sept. 2	Sheep.	Auction Mart, St. Boswells—96 Ox. X. las at 50*s.* 6*d.*	..	..	..	..	..	..	96	..	..	..	..	348 0 0	..	..	..	..	626 4 8	
		50 H.B. las at 45*s.*	..	..	..	..	..	..	..	50	..	..	..		..	..	..	..		
		110 Leic. X. at 37*s.* 3*d.*	..	..	..	110	..	..	..	..	..	..	200 0 0	..	..	..	..	..		
		55 B.F.W. at 29*s.*	..	20	..	..	35	..	..	..	..	28 0 0	50 4 8	..	..	..	..	..		
		less exp. £13, 5*s.* 10*d.* = 10½*d.* p. hd.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		
3	Sundry	T. Jones, Blackhill—Rent for ground game	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10 0 0	10 0 0	
10	Cattle	W. Smith, Edinburgh—8 Fat Cattle at £30 f.o.r.	..	..	..	..	..	..	..	..	..	..	..	..	240 0 0	..	..	..	240 0 0	Finish of lot
16	Sheep	J. Wilson & Co., Bradford—8000 lbs. net. B.F. wool at 9*d.* per lb. f.o.r.	..	..	..	..	..	..	..	..	300 0 0	180 0 0	120 0 0	..	..	..	..	..	300 0 0	
20	Crop	W. Watson & Co., Leith—50 qrs. old Oats at 30*s.* p. qr.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	75 0 0	..	75 0 0	
		Carry forward	5	70	..	160	35	10	276	140	300 0 0	293 1 6	468 8 8	1050 2 4	552 10 6	60 0 0	75 0 0	10 0 0	2509 3 0	

NOTE.—The columns to left of Black Line are for details for information only, and are not to be added to the Cash columns to the right of the Black Line.

NOTE.—The Totals to the right of the Black Line added horizontally should equal the Totals in last column added vertically, i.e. £2509, 3*s.* both ways. This is a useful check for arithmetical or clerical errors.

EXPENDITURE 1926-27.

Date.	Section.	PAID TO.	DETAILS.	Car.	Sheep.	Cattle.	Horses.	Seeds.	Manures.	Feeding Stuffs.	Wages.	Merchants' and Tradesmen's Accounts.	Rates, Taxes and Insurances.	Rents, including Grass Parks, Winterings and other Subjects.	Sundry.	TOTAL.
				£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
			Brought forward . .	35 10 0	307 10 0	280 0 0	3 10 0	130 0 0	180 0 0	150 0 0	260 10 0	80 0 0	40 0 0	400 0 0	5 13 9	1837 3 9
Sept. 4	Wages	Monthly Wages to date .	Pages 31-44 in Wages Book	..	..	..	..	..	..	..	106 7 6	..	..	..	..	106 7 6
10	Sheep	Jones & Co., Auctioneers, Kelso Ram Sales.	3 Ox. Tups off Shortcroft, Nos. 1, 4 and 5, at £25, £15 and £30 . .	..	70 0 0	..	..	..	..	..	..	..	..	..	..	70 0 0
11	Sundry	Lauder Garage Co. .	Sundry haulage . .	..	..	..	..	..	..	..	..	..	..	..	6 5 0	6 5 0
11	Merchants	Farmers' Stores, Leith .	1 cwt. Red Paint, Motor Tyre, &c. . . .	4 10 0	..	..	..	..	..	..	..	7 5 0	..	..	..	7 5 0
16	Insurance	N.F.U. Ins. Soc. Ltd. .	Premium on Car . .	3 5 0	..	..	..	..	..	..	..	..	3 5 0	..	..	3 5 0
16	Sundry	Scotch Plant Breeding Research Society.	Subscription for current Year	..	..	..	..	..	..	..	..	..	..	..	1 0 0	1 0 0
Oct. 4	Insurance	Post Office, Lauder .	N.H.I. and Pensions Insurance Stamps . .	..	..	..	..	..	..	..	..	..	19 1 6	..	.	19 1 6
			Carry forward . .	43 5 0	377 10 0	280 0 0	3 10 0	130 0 0	180 0 0	150 0 0	366 17 6	87 5 0	62 6 6	400 0 0	12 18 9	2050 7 9

NOTE.—Column to left of Black Line is for information only, and is not to be added to other totals to right of the Black Line.

NOTE.—Totals to right of Black Line added horizontally should equal total of Totals column added vertically, i.e. £2050, 7s 9d. both ways.

In working this book the separate sections are added up, and the totals column is added up. As a check on accuracy the total of the sections columns along the foot should give the same figure as the totals column. That is, the totals should be added both ways to give the same result.

No entry should be made except when actual payments are made or received, and no bank transactions should be entered in this book. A bank transaction is not a farm transaction at all, and such entries merely create confusion. These bank transactions, such as cheques and payments into the bank, are all shown in the *Bank Pass Book* (2) and verified by the cheque book counterfoils and by the pay-in-slip counterfoils, therefore any further accounting of these is redundant and futile. The bank supplies books of pay-in-slips with counterfoils, free to customers on application.

It must be emphasised that no transactions but farm transactions should be entered in the cash book. For instance payments into deposit receipt, deposit receipt interest, income tax, &c., should not be entered in the farm accounts. These are private and not farming matters.

For convenience a page at the end of the cash book might be devoted to a record of deposit receipts and their interest.

County and parish rates, however, are farm items and should be entered in the proper column. The nett wages are entered in the wages column and the N.H.I. stamps are entered when bought in the insurance column.

There are books with many rulings on each page, sold in different styles, amongst which most farmers will find one to suit. Mostly it takes about 10 to 13 columns on the expenditure side and somewhat fewer on the receipts side, and it is better to have plenty columns. Each one can enter his headings in ink to suit himself, or better still he can at small extra cost get the headings printed in specially as required. A book specially made and ruled is satisfactory, but more expensive. However, it is worth it, as the cost spread over a 19 years' lease is only a few shillings per annum, and one gets exactly what one wants.

Wages should be made out in detail in the *Duplicate Wages Book* (3), a summary taken from this every four weeks, and only the total for the month entered in the cash analysis book.

Similarly, if there is any other item in which a lot of small transactions of the same kind take place, a similar plan could be followed.

A suitable duplicate book is the ordinary carbon duplicating book with a tear off leaf, about 8½ in. by 5½ in.

The above cash analysis system then at the foot of every page shows the following at a glance:—

1. Cash balance to date (in hand and in bank).
2. Receipts and expenditure to date in every department of the farm.
3. Numbers and quantities of commodities sold.

Further details to answer any particular question are very readily available, and it is ready at the end of the year for the annual balance without any further clerical work.

As regards debts due by the farmer, he has a record of them in his file of unpaid accounts, and as regards debts due to him, he has a record in his *Duplicate Invoice Book* (4) if it is necessary to keep one. Most farmers' sales being all for cash, such a book is often unnecessary. A book exactly the same as the wages book will do.

All receipts and sale notes should be folded lengthways to about 3 ins. wide, and on the back should be written (1) the date, (2) name of party dealt with, (3) nature of business, (4) cash paid or received. These receipts and sale notes should be kept in two separate bundles in order as entered in cash book, and held together by a tape or a rubber band.

Yearly Balance.—For his annual balance he must close his books at a stated date every year, and he at once has his cash balance to that date and all necessary information *re* departments. A valuation of his stock for the previous year, deducted from a valuation on identical lines for the present year, gives him his valuation surplus or deficit. This added to or subtracted from his cash balance gives the profit or loss for the year.

The valuation question, important though it is, need not be gone into here, because it is the same under the cash analysis system as under any other.

Briefly, the writer thinks that holding stocks should be valued at the same price per head every year, ignoring market fluctuations, and flying stocks should be valued at cost or market value, whichever is the lower.

Any other plan as regards holding stocks—say on sheep breeding farms—would simply lead to the valuation showing fictitious losses or profits. The rule that a profit or a loss is not made until the capital is realised is a sound one. A sheep farmer's capital loss or profit can not be ascertained until he sells out, which may be next year or in nineteen years. His breeding stock is absolutely "fixed capital," and unrealisable until he goes out of business. Similarly the regular stud of work horses should be put in at the same value per head every year, market fluctuations being ignored. All attempts at juggling with valuation prices so as to show illusive losses or profits are to be deprecated, and a plain, straightforward valuation should be the ideal aimed at.

Depreciation for implements should be deducted according to the Inland Revenue Rules as arranged with the National Farmers' Union some years ago. Information as to these can be got from the Secretaries of the N.F.U. or the Surveyor of Taxes for the district. Alternatively implements should just be put in at the same slump sum every year.

Growing crops, unexhausted manurial values and such items, the valuation of which is merely guesswork, should not be shown in the valuation at all.

Whatever plan is adopted, the really important thing is to adhere to the same system every year.

An example is given herewith of an annual statement of accounts based on the cash analysis book.

SAMPLE OF ANNUAL STATEMENT OF ACCOUNTS.

Summary of Valuations at Whitsundays 1926 and 1927.

ITEMS.	Whits. 1926.	Whits. 1927.
1. Sheep	£10,000	£10,600
2. Cattle	980	750
3. Horses	700	700
4. Corn and Foodstuffs on hand	300	250
5. Dung, Straw and Hay	250	280
6. Implements and Equipment...	1,000	980
7. Other Produce...	10	20
TOTALS	£13,240	£13,580
Difference being Valuation Surplus ...	340	...
	£13,580	£13,580

(Taken from Cash Analysis Book.)

Summary of Expenditure and Receipts, Whitsunday 1926 to 1927.

ITEMS.	Expenditure.	Receipts.
1. Sheep: Bought 200, sold 2000	£800	£4,500
2. Cattle: Bought 20, sold 30	450	900
3. Horses...	40	60
4. Seeds	130	...
5. Manures	400	...
6. Feeding Stuffs	500	...
7. Wages, Cash. No Salary for farmer ...	1,400	...
8. Merchants and Tradesmen...	500	...
9. Rates, Licences, Insurance. No Life Insur.	150	...
10. Rent	800	...
11. Sundry, including House Rent	80	70
12. Crop, including Produce for House ...	...	200
TOTALS	£5,250	£5,730
Difference being Cash Surplus	480	...
	£5,730	£5,730

PROFIT AND LOSS STATEMENT.

Cash Surplus as above ..., ...	£480
Valuation Surplus as above	340
TOTAL PROFIT for Year 1926-1927 ...	£820

No mention is made above of accounts unpaid by or money due to the farmer, as in many cases accounts are all squared up at Whitsunday. However, these can be added or deducted as may be necessaiy.

The writer confesses that for sixteen years he worried along in the old-fashioned way with cash book and ledger, and like many another he usually was in arrears in writing up his ledger, so that

(NAME OF FARM printed here.) (NAME OF HIRSEL printed here.)

Shepherd *Returns for Month of* 19

BREEDING STOCK	No Last Month	DECREASE				INCREASE		No Left	Remarks
		Dead	Sold	Trans ferred	Total	Bought	Trans ferred		
Ewe Hoggs									
Do									
Do.									
Gimmers									
Do									SHEAR-LING
Do.									
One Crop									
Do									2 SHEAR
Do.									
Two Crop									
Do									3 SHEAR
Do.									
Three Crop									
Do.									4 SHEAR
Do									
Tups									
Do									
Do									
Do.									
Do.									
TOTAL BREEDERS									
SELLING STOCK									
Lambs									
Do.									
Do									
Do.									
Sundry									
Do.									
Do									
Do.									
Do									
TOTAL SELLERS									
GROSS TOTALS									

NOTE.—Classes change name on June 1st only.

at the annual balance there was a lot of drudgery writing up to do, and it was only after that was done that one could get accurate information regarding the different departments. Since adopting the cash analysis system eight years ago, no such trouble has arisen nor is it possible for it to do so. The new system has proved itself superior in every way, and after eight years' trial of it, nothing would induce the writer to revert to the old, cumbrous, uninforming system.

Stock Returns.—It is very useful for farmers with one or more shepherds to get from them a monthly rather than the older-fashioned half-yearly stock return. To make this easier for both parties it is a great advantage to use some printed form, which can be filled in every month and which gives at a glance all the information the farmer is likely to want. The shepherds soon understand them thoroughly and take a pride in having them correct. These returns if filed away are useful to both shepherd and farmer for present use and future reference. On the previous page is a form evolved by experience and found useful for several years now. Some printers have standard forms of this type, but it is better for the farmer to get say 300 printed to suit his own needs and ideas. These will cost about 20*s.* to 30*s.*, which, spread over a lease, is negligible.

The sample shown is for a breeding mixed arable farm. A form suitable for a purely hill or breeding farm would be much simpler and smaller, though of course on the same lines.

THE BIOLOGIST ON THE FARM.—No. XXIII.

By Professor J. ARTHUR THOMSON, M.A., LL.D.

Chain Instincts in Lambing Sheep.—Instinctive behaviour depends on inborn predispositions of the nervous system which enable the animal to perform an effective series of actions without learning or apprenticeship, but it has also its mental or psychical side, for it may be suffused with awareness and backed by endeavour. Instinct is an inborn capacity for doing apparently clever things, and one of its common features is that it includes a series of actions which follow one another in a constant and definite order. It is believed that one link in the chain acts as the stimulus for the next. Thus the nest-building of birds is linked to the pairing, the egg-laying to the nest-making, the brooding to the egg-laying, and so on. Mr. A. H. H. Fraser has recently applied this idea of chain instincts to the behaviour of sheep in lambing (*British Journal of Psychology*, xvi., 1926, p. 310), and his interpretations are very interesting. While there is notable individuality on the sheep's part, while there is often an artificiality of conditions that prevents the series of actions from following its normal course, and while the instinctive is improved by experience, as is evident in contrasting the behaviour of a ewe with that of a gimmer, there is a normal chain of events.

(*a*) The first link is isolation. The ewe leaves the flock and

wanders restlessly about the field. (*b*) Secondly, the ewe searches out a place to make a bed. Using her fore-feet alternately, she scrapes a nest, seldom leaving it if undisturbed until the lamb is born. On a level grass field this (probably ancient) scraping may be quite futile. (*c*) Parturition then occurs, and numerous observations point to the conclusion that the stimulus for the full awakening of the maternal instinct in sheep is the taste of the amniotic fluid. (*d*) There follows the detailed care of the lamb, cleaning and suckling it. (*e*) Finally there is the return to the flock.

If in artificial conditions there is lack of isolation, and if the ewe has stimuli (of sight, hearing, and probably smell) from a lamb before her own is born, then the perversion known as "lamb-theft" may occur. Once a lambing ewe has licked another lamb, it is often some time before her pains recommence, and this delay in parturition may result in the death of her own lamb. This biological meaning of lamb-theft, which Mr. Fraser suggests, seems very reasonable; lamb-theft is the result of a disturbance in the instinctive chain, and the disturbance is due to artificial conditions which give the lambing ewe the stimulus of a lamb before, instead of after, parturition.

Intelligence of a Pigeon.—To Mr. Arthur H. Sim, Pressendye, Milltimber, Aberdeenshire, we owe a careful account of the intelligence of a cock Homer pigeon. He was due to relieve the brooding hen who was sitting in a dovecot with an alighting board at the entrance, which was closable with a sliding shutter working in a bevelled rail. As the entrance was half-closed, the pigeon got his head and "shoulders" in and succeeded in shoving the shutter along. He was taken out and the same thing was repeated several times, so that he became quite expert in sliding the door.

After some time a small piece of wood, about two inches long and half an inch broad was laid in the groove of the bevelled rail so that the door could not be pushed along far enough to let the pigeon in. After some fruitless pushing, the pigeon seized the piece of wood in his beak and threw it on the ground. He then slid the door along and went in.

This performance was repeated several times, until the pigeon gave it up and remained passive on the alighting board for almost ten minutes, Mr. Sim standing three or four yards away. The next step was of much interest. The observer went into the house close by and watched from a window. As soon as he reached his post of observation, he had the pleasure of seeing the pigeon seize the piece of wood and toss it into the air, afterwards effecting entrance as he had done before. This again was repeated several times, and the result was the same. When Mr. Sim remained near the dove-cot the pigeon did nothing. When he retired to the house, the pigeon immediately made its way in by removing the small piece of wood and sliding the door along. The observations lasted for about three quarters of an hour when they were discontinued, partly because nothing new happened, and partly because the pigeon became exceedingly impatient to be on the nest. There are four points to be noticed: (*a*) the dexterous sliding of the door along; (*b*) the removal of the piece of wood

that prevented the door being opened far enough; (*c*) the cessation of endeavour when the pigeon perceived that a solution of the problem did not meet with its due reward, and (*d*) the immediate repetition of the activity when there seemed to be a chance of success.

A Very Unusual Case.—To Mr. George Beattie, Drum, and to Mr. James Adams, Aberdeen, we are indebted for a circumstantial account of what is, so far as we know, a very unusual case of animal kindliness. A young cat was in her parturition pains in a barn and was having a very bad time. It did not seem likely that she would live through it. When Mr. Beattie returned in an hour's time, he was surprised to find the mother of the young cat acting the part of midwife. He saw it pull out a young kitten with her teeth and she did this for two others. This shows the strength of maternal affection—and something more.

The Rat-tailed Maggot.—A correspondent has sent us this quaint creature of the farm, the larva of the somewhat bee-like drone-fly, Eristalis tenax, that is sometimes seen panting on the dandelions by the side of a sunny road. The fly lays her eggs in very foul fluid, beside a manure-heap or the like, and the larva feeds on the decaying organic matter which it draws into its mouth with the help of a suction-pump. When full-grown it is a greyish, soft maggot, two-thirds of an inch in length, with seven pairs of short-hooked stumps beneath, by means of which it creeps about. But its most remarkable feature, described long ago by Réaumur, is the telescopic tail, which can be lengthened out to reach the surface of the water or whatever the fluid is. The narrower terminal part of the tail can be retracted into or pushed out from the wider lower part; and this also is contractile. At one time the tale may be half an inch long, at another time it may be as much as four inches! Inside the telescope there are two air-tubes or tracheæ leading to those of the main body, and at the tip there are two openings or spiracles by which the air is taken in. There are some recurved bristles at the tip of the tail, which can be spread out on the surface film. They serve to keep the spiracles open and they sometimes suspend the larva from the surface. The full-grown larva usually leaves the water and pupates in damp earth. There is a shortening of the body and the tail; two new breathing-tubes grow out on the thorax, the maggot's skin becomes brownish and hard; and inside this the great change or metamorphosis occurs, as the result of which in eight or ten days an active fly emerges. There are two broods in the year. It may be noted that the drone-fly is not in any way harmful; but we have known of a rare case where the very hardy larva was passed out from man's food-canal.

The American Ostrich.—Ostrich-farming, which concerns the true African ostrich, Struthio, is not at present what it was some years ago, for the tide of fashion has receded from the wearing of borrowed plumes. As to the American ostrich, Rhea, though its feathers were never so much in request as those of the true ostrich, they cost the bird dear in bygone days and led to ruthless elimina-

tion. More recently the interesting bird has fallen on evil days, for while it was just surviving against the skill of the South American horsemen who were dexterous to throw a long-thonged ball or bolos round the bird's graceful neck, it has no chance at all against fire-arms, and is rapidly dwindling in numbers. Archaic and interesting, it seems to be passing; hinc illæ lachrymæ.

Part of the interest of the South American ostrich concerns its breeding habits, which have been the subject of recent study by Mr. A. F. J. Portielje of Amsterdam. The rhea is polygamous and the cock is responsible for the brooding. He incubates over a score of eggs and those that are laid beyond that number come to nothing. An instructive point is that a single egg, dropped early, seems to have no meaning to the cock; the brooding instinct is not roused till he sees an egg, or better still, several eggs, lying in the scraping that is the nest. Then he begins to brood and he appears to attract the hen-bird to visit him. When she draws near and drops an egg close to the "nest," the cock gets hold of it with his beak, neck, and flightless wings, and draws it under his body. In a remarkable way he makes a hook of his long neck and collects the egg!

This illustrates a high development of instinct and yet it has to be considered along with not less striking limitations. Thus, as we have said, a single egg, dropped anywhere, means nothing to the cock, as far as his behaviour indicates. Moreover, he seems to be much puzzled by the youngsters that may hatch out ahead of the others. He does not recognise the first one or the first two as having anything to do with him. He may treat the first chick as an intruder and throw it away. This shows the extraordinary limitedness of instinct as contrasted with intelligence. Soon, however, when there is a waning of the instinct to brood on the never-too-much-to-be-sat-upon eggs and many chicks are hatched, the proud father becomes a careful and courageous parent—almost as good as a mother!

The Brains of a Hen.—As a general rule it may be said that animals are not cleverer than they need to be. Therefore if domestication means a sheltered life, plenty of food, and little danger or adventure, we may expect expressions of intelligence to be few. Hence we speak contemptuously of "the brains of a hen." It is quite different with domesticated animals, like horse and dog, that become man's partners and share in responsibilities. We do not say that the hen's brains have degenerated—they seem to differ considerably in different breeds—but we say that expressions of intelligence on the hen's part are not common. It takes a long time for brains to degenerate; evolution up or evolution down is a slow racial process; but it does not take long for a brain to fall asleep. That is an individual result, and we think that it is illustrated in hens. This is borne out by the educability of chicks. If an instinct is an inborn ready-made power of doing apparently clever things, then chicks have relatively few instincts. Almost from the first they can peck with precision at flies moving on the wall of the hen-run; they can jump neatly from an eminence eight times their own height; they can scratch their head with their toes; and they have a few other instinctive accomplishments. Yet how

few compared with a young ant or a young bee! Chicks hatched out in an incubator paid no attention at all when their unseen and previously unheard mother clucked outside the door. They are not instinctively aware that the presence of a cat spells danger. Even when thirsty they do not instinctively recognise water, though they may be standing in a saucerful. They will stuff their crop once or twice with worms of red worsted,—a very unprofitable meal! Yet how quickly they learn—to recognise various sounds, to discriminate between different materials, to reject dangerous food such as bees, and so on. There are few animals so educable as chicks—up to their limits. We cannot believe that this educability disappears in the hen; we believe that it simply falls asleep. This view is supported by some experiments made by Katz and Revesz. When they scattered mixed rice and wheat before their hens, they noticed that the grains of rice were always picked up first. So they tried a hungry hen with 20 rice grains which were glued irregularly to a slab of wood about 5 inches square; and between these they placed ten loose grains of wheat. At first the hen tried the rice grains, but could not detach them. It then picked up the grains of wheat. When all the ten were picked up, there was a rest for fifteen seconds, and then the hen got another lesson, and so on till it had seven. On each occasion the observers counted the number of pecks that the hen made before all the ten grains of wheat were swallowed. The figures are very interesting: 35, 19, 19, 16, 12, 10, 10. In other words, the hen had learned by the sixth lesson not to waste time over the rice grains, which were fastened, it may be noticed, with invisible glue. It had eliminated useless movements, as we ourselves do in learning to play a motor game or to ride a push-bicycle. We conclude that hens are not so stupid as they look.

Are the Results of Training Transmissible.—The offspring of an educable well-trained collie are sometimes very adept, but it is difficult to be sure that there is hereditary handing-on of more than the quality of good natural ability, including teachableness. It is said, moreover, that a young collie learns best from its mother, and care must be taken not to mix up the outcome of a good constitution with the results of good education. But the question of the possible transmission of the results of training is one of the highest importance, and any factual contribution that can be made to the question is welcome.

When the distinguished Russian physiologist, Professor Pavlov, was in this country a few years ago, he alluded to his experiments in training white mice. He trained a number of them to run to their feeding-place when he rang a bell, irrespective of the presence or absence of food in the dish. A neuro-muscular associative linkage was established between the sound of the bell and the possibility of food. There is no doubt that this association can be formed; the question is whether the offspring will be hereditarily influenced by what their parents learned. Pavlov found that three hundred lessons were needed before the association was established. Miss Isobel Dean, B.Sc. (Hons.), working in our laboratory, found that the association could be established in about fifty lessons. There is nothing in this, however, for natural

educability probably varies with the breed of mouse. The crux is in regard to subsequent generations.

Professor Pavlov found that in the second generation of mice, only one hundred lessons were required, in the third only thirty, in the fourth only five! We have not been able to see any authorised report of these experiments, but they are obviously of great interest, especially when we recognise the distinction and experience of the observer. On the face of it Pavlov's conclusion, *if correctly reported*, suggests the hereditary entailment of a somewhat subtle "acquired character." The experiments suggest that individual training may have a specific and representative influence on the race, yet we cannot, of course, accept this conclusion until we have before us a full account of the circumstances and a precise statement of the numbers of mice experimented with. In the second generation of mice, about eight in number, with which Miss Dean experimented, there was no appreciable reduction in the number of lessons required to establish the association. The behaviour of the second generation was exactly like that of their trained parents. The precise figures will be published and the very careful circumstances of the experiment will be explained, but in the meantime we may say that there is no corroboration of the result attributed to Professor Pavlov. It may also be noted that Dr. E. C. MacDowell has made (1924) somewhat similar experiments with white rats at the Carnegie Institution, Cold Spring Harbor, Long Island. He trained them to master a maze and afterwards did the same with their offspring and grand-offspring. He found that the training of the ancestors (we are not aware of the numbers) did not facilitate the learning of the descendants. "Children from trained parents, or from trained parents and grandparents, take as long to learn the maze habit as the first generation trained." But we must try again!

THE EFFECT OF PASTEURISATION ON THE NUTRITIVE VALUE OF MILK.

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MILK, though such a valuable foodstuff for children, is one in which disease-causing bacteria flourish readily. In the past there have been many local outbreaks of typhoid, summer diarrhœa in infants, sore throats and certain other infectious diseases which have been traced to a contaminated milk supply. Even more serious than the risk of these epidemics is the danger of infection by tubercle bacilli in milk. A large proportion of the cases of tubercular glands and bones in children is believed to have their origin in milk from tubercular cows.

In the last few years there has been a great improvement in the conditions under which milk is produced and distributed, and the

milk supply of the country is undoubtedly much more wholesome than it was even a few years ago. Although the vast majority of the population is consuming milk daily, the number of local epidemics, now traceable directly to an infected milk supply, is surprisingly small. We have undoubtedly reached the stage when the advantages to public health of an increased milk consumption far outweigh the disadvantages of the danger of milk-borne infectious diseases. The danger, however, is not yet completely eliminated, and one of the urgent problems of public health authorities is to obtain a supply of milk which is abundant and cheap and, at the same time, free from the danger of conveying disease.

Broadly speaking, there are two methods of ensuring that milk will be reasonably safe. By the first method, which produces "raw" milk, the milk is obtained from perfectly healthy cows, and then kept free from bacteria by scrupulous cleanliness in all the processes connected with its production and distribution. Largely owing to the work of the National Institute for Research in Dairying at Reading and the dairy instructors and instructresses at colleges of agriculture, a great advance has been made in the last two or three years in methods of milk production and distribution. It has been shown that reasonably clean milk can be produced without any great capital expenditure in alterations of byres, provided sufficient enthusiasm is shown on the part of those handling milk. The question of the additional cost of producing clean milk has been discussed in a recent article in this Journal by Liversage, who estimates that Grade A Tuberculin Tested milk, one of the grades of "raw" milks sold under licence, can be produced for an additional cost of 3d. per gallon. The greatest difficulty is the elimination of all cows reacting to the tuberculin test. Unfortunately there are comparatively few herds which could be certified as completely free from tuberculosis.

By the second method, which produces "pasteurised" milk, the milk is heated to a temperature which destroys any bacteria which may be present.

There are three grades of "raw" milk and two of "pasteurised" which are at present sold under licence. The definition of these grades need not concern us here.

The relative merits of "raw" and "pasteurised" milk have been the subject of a considerable amount of discussion in this country. On the one hand it is argued that pasteurised milk is safer than any grade of raw milk because, even with the utmost precaution, the milk may become infected at the milking or subsequent handling before bottling. Some of the cows may become tubercular between the tests, or may even be tubercular at the time of the tests and fail to give a positive reaction, and therefore be retained in a herd supposed to be free from tuberculosis. Pasteurisation is held to be a safeguard against these possible sources of infection. On the other hand the view is expressed that heat affects the physiological properties of milk in such a way that its nutritive value for children is decreased, and therefore pasteurisation should be regarded as merely a temporary measure which should be discarded so soon as it is possible to have all milk which

is put upon the market produced from healthy cows, and under conditions which prevent the possibility of contamination.

The evidence that pasteurisation adversely affects the nutritive qualities of milk depends chiefly on the results of feeding experiments with guinea pigs and on clinical observations. The former show that heat renders the milk less able to protect guinea pigs against scurvy, and the destruction of vitamins has been claimed to be the chief disadvantage of heating. Work with rats, however, seems to suggest that the defective nutrition in these animals fed on heated milk may be due to loss of calcium by precipitation during the process of heating (Daniels and Loughlin, 1920).

In this country more and more pasteurised milk is being used, and a considerable amount of capital is being invested in pasteurising plant. In view of the economic and public health importance of the subject, therefore, it seems desirable to carry out further investigations to determine to what extent heating affects the nutritive value of milk and the factors upon which the effect depends. An investigation was, therefore, carried out to obtain further information on the following points, viz. :—

(1) The physico-chemical changes induced in milk by heat

(2) The effect of these changes on the rate of absorption and retention by a growing animal of the calcium, phosphorus and nitrogen, i.e. the chief bone-forming and muscle-forming elements, and

(3) The difference between the nutritive value of pasteurised and fresh milk as determined by the health and rate of growth of calves.

The results obtained in (1) and (2) have been dealt with in detail in previous publications (Magee and Harvey, 1926) and need therefore be only briefly summarised here.

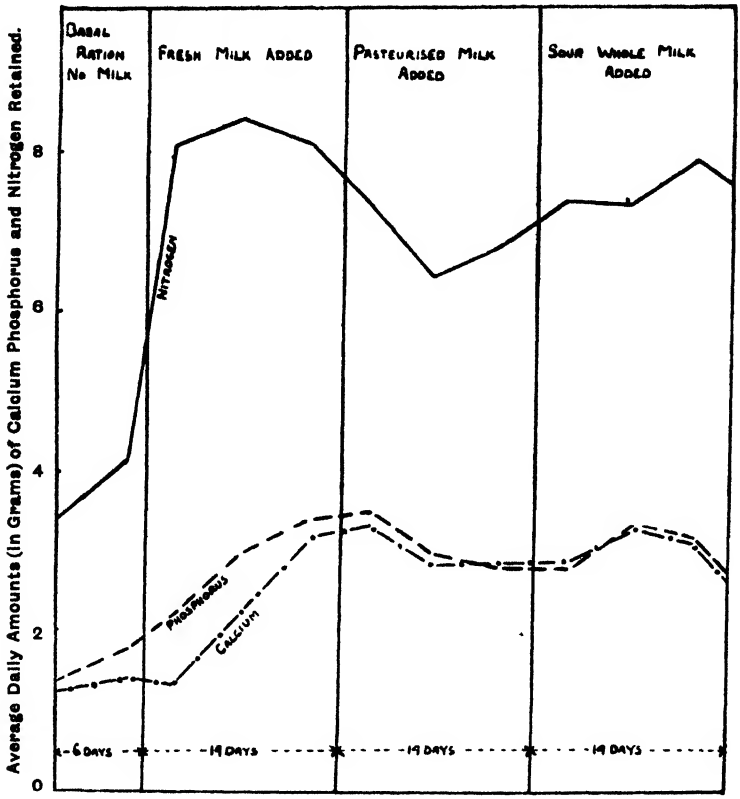
Physico-chemical changes induced in Milk by Heat.—It was found that heat reduced the amount of soluble calcium in milk. In fresh milk about 26 per cent. of the total calcium is in the diffusible or soluble form, in pasteurised milk about 20 per cent., and in milk which has been kept at boiling point for one hour about 15 per cent. The losses in soluble calcium were believed to be due to the formation of a colloidal form of calcium phosphate. Souring of milk causes a rise in the soluble calcium to an extent depending on the degree of souring.

It is interesting to note here that the heating of milk interferes with the processes involved in cheese-making. This is most probably due to the reduction of soluble calcium, since for cheese-making the natural properties of fresh milk can be restored by adding a soluble calcium salt to the heated milk.

Tests of the rate of digestion of milk before and after heating were made by placing some intestinal ferments in test tubes with samples of the milk and noting the rate of the breakdown of the protein. No differences were obtained in rate of this form of digestion.

From the chemical point of view, the most important change produced by heat is the reduction in the diffusible or soluble calcium.

Difference in rate of absorption and retention of Calcium, Phosphorus and Nitrogen in Diets with Fresh and Pasteurised Milk respectively.—In these experiments growing pigs were fed on a ration of cereals to which was added either fresh milk, pasteurised milk or sour milk. The nature of the results obtained is shown on the following graph.



It will be seen that on the introduction of milk the rate of absorption of calcium, phosphorus and nitrogen rises rapidly. As the rate of retention of these elements is an indication of the rate of growth of bone and muscle, this part of the graph forms an excellent illustration of the value of milk for growing animals.

From the point of view of the present investigation, however, the most important part of the graph is the central part, showing that when pasteurised milk is substituted for fresh the rate of retention of these bone and muscle forming elements falls, to rise again when sour milk is substituted for pasteurised.

From the results of the investigation on the physico-chemical changes produced by heat, it was thought that the decreased retention of calcium, phosphorus and nitrogen in pasteurised milk might be due to a decrease in the amount of soluble calcium. Further experiments were therefore done in which the rate of retention of these elements on a diet with fresh

milk was compared with the rate of retention on a diet with pasteurised milk to which some soluble calcium had been added. The amount added was equal to twice as much as the amount of soluble calcium lost in the process of pasteurisation.

Fresh milk was fed for 15 days, then pasteurised milk plus calcium chloride was fed for 15 days, and finally fresh milk was fed for a final period of 12 days.

The following table shows the average amount of these retained in grams for three-day periods:—

TABLE I.

	Fresh Milk.	Pasteurised Milk plus Calcium Salt.	Fresh Milk.
Calcium (CaO)	11·25	13·35	12·57
Phosphorus (P_2O_5) ...	14·76	16·21	13·95
Nitrogen (N_2)	32·81	33·39	29·64

It will be seen that the feeding of pasteurised milk plus a soluble calcium salt gives a greater retention of calcium phosphorus and nitrogen than in the case of fresh milk alone.

The amount of calcium added was about ·97 grs. per three-day period. The increase in the amount retained, as compared with the average of the two fresh milk periods, was 1·43 grs. The increase in the retention of calcium was therefore greater than the amount of soluble calcium added.

This effect of an increase in the amount of soluble calcium on the rate of absorption of calcium, phosphorus and nitrogen suggests that the reduction of soluble calcium through heating may decrease the nutritive value of pasteurised milk as compared with raw milk. The following experiments were therefore undertaken.

Feeding Experiments with Calves.—Feeding experiments were carried out to determine whether any difference could be detected in the health and rate of growth of calves fed on pasteurised milk as compared with calves fed on fresh milk, and also whether the addition of a soluble calcium salt to pasteurised milk would affect its nutritive value.

The milk to be pasteurised was taken from the whole mixed bulk from which the fresh milk was obtained, so that, apart from the result of the pasteurisation, it was the same as the fresh milk. In experiment 3 the pasteurisation was carried out at the Institute. In the other two the pasteurisation was done at a commercial dairy. In experiment 1 the "Flash Method" was used, and in the other two experiments the "Holding Method."

The calves were reared in the ordinary way, milk only being given for the first forty or fifty days, and then some form of concentrate and roughage gradually added.

The animals were weighed regularly to ascertain any effects on the rates of increase in weight. Except in experiment 2, which was carried out on closely related pedigree animals, too much importance should not be attached to the weights, because the

calves used were ordinary commercial calves, and although they were arranged to make the groups as comparable as possible with regard to weight, age and general condition, the inherited rate of growth varied in the different individuals, and there was in some cases a greater difference between the individual weights of the same group than between the average weights of the different groups.

Five experiments were attempted. One was abandoned as the results of the bacterial counts of the pasteurised and fresh milk threw doubt upon the efficiency of the pasteurisation. In another, the calves, which had been bought-in for the test, suffered from diarrhœa at the beginning of the experiment, and later developed a skin condition. Although they were all in fairly good condition by the end of the test, the results were regarded as unreliable.

Experiment 1. (1923-24.) (A. Crichton and J. A. Crichton.)—There were four groups each with 4 polled calves: two bulls and two heifers. The first group received fresh milk; the second the same milk pasteurised; and the third pasteurised milk plus 8 grs. calcium lactate per 1000 cc. milk. The animals were fed on milk only for 50 days, and then milk with the addition of concentrates for 75 days.

Table II shows the average increase in weight in lbs. of different groups.

TABLE II.

	Fresh Milk.	Pasteurised Milk.	Pasteurised Milk plus Calcium Lactate.
50 days milk only	58	51	57
75 days milk plus concentrates ...	135	125	140
Total period 125 days ...	193	176	197

When the experiment finished all the animals receiving either fresh milk or pasteurised milk plus calcium lactate were in excellent condition. The animals on the pasteurised milk only did not have the same "bloom," but there were no gross signs of malnutrition. Seen apart from the others they would have been regarded as good average calves.

Experiment 2. (1924-25.) (Miss E. Haldane.)—This experiment is of special interest because the animals used were closely related pedigree animals. They were Ayrshire calves all from the same sire. They had been born on the Experimental Farm and had been treated uniformly from the day of birth until the beginning of the experiment, when all the animals were in perfectly healthy condition.

Three calves were given pasteurised milk and three pasteurised milk plus calcium lactate. After the experiment had been running for some time, two other similar calves became available. They were given fresh milk for 45 days, and they served as a control for the milk only period of the other two groups.

Table III shows the rate of growth of the individual animals in the different groups.

TABLE III.

	Fresh Milk.		Pasteurised Milk.			Pasteurised Milk plus Calcium Lactate.		
Calf No.	1	2	3	4	5	6	7	8
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Milk only— 45 days	55	55	56	48	41	56	56	53
Milk plus Concentrates— 45 days	...	...	51	63	52	69	70	65
Total	...	...	107	111	93	125	126	118

All the calves in the group receiving pasteurised milk developed signs of malnutrition, which became more pronounced during the second period, at the end of which definite signs of rickets had appeared in two of the three animals. As the calves were valuable, it was decided to terminate the experiment on the ninetieth day.

Experiment 3. (1925–26.) (W. Middleton.)—This experiment was carried out as a further test of the effect of the addition of a soluble calcium salt to pasteurised milk. There were two groups each of three cross Aberdeen Angus bull calves. Both groups received pasteurised milk *ad lib.* One group had in addition 12 grs. calcium lactate per 1000 cc. milk. The experiment was continued for six months.

At the beginning of the experiment the calves receiving the extra calcium lactate suffered from diarrhœa, which, however, ceased after about a week. Thereafter all the animals remained in good condition.

Table IV shows the average increase in weights in lbs.

TABLE IV.

	Pasteurised Milk.	Pasteurised Milk plus Calcium Lactate.
First 2 months	75	63
Second 2 months	92	101
Third 2 months	88	97
Total	255	261

At the end of the experiment the coats of all the animals receiving the calcium lactate were better than those of the other group, which were rather dull and dry. No other symptom of malnutrition was noted.

Discussion of Results of Feeding Tests.—In the two tests in which pasteurised milk was compared with fresh milk, the average increase in weight was greater in the calves receiving fresh milk than in those receiving pasteurised milk. In all the tests the rate of

growth was greater in the calves receiving the pasteurised milk plus the soluble calcium salt than in those receiving pasteurised milk only.

All the calves receiving either fresh milk or pasteurised milk plus the soluble calcium salt remained in perfect health. Those receiving pasteurised milk were not in such good condition as the others. They had not the same "bloom" of perfect health. It was only in experiment 2, however, that gross signs of malnutrition appeared.

It should be emphasised that the number of experiments and the number of animals in the individual tests were too small to enable definite conclusions to be drawn. The results, however, seem to indicate that the process of pasteurisation affects the physiological properties of milk in such a way as to decrease its value for promoting growth and maintaining health in young animals. It must be kept in mind, however, that even under the rigorous conditions necessary for these experiments, fairly healthy calves were reared in two out of the three tests. This shows that it is possible to rear calves on pasteurised milk, and the results of the test with calcium lactate show that if the necessary additions be made to pasteurised milk, the rate of growth and health of the calves would probably be as good as that of animals reared on fresh milk.

Discussion on Results of Investigation.—The results obtained, so far as they go, seem to show that the process of pasteurisation decreases the nutritive value of milk for calves. The important question is whether pasteurisation reduces the value of the milk for children. On this point we have little direct conclusive evidence. The results of tests with either guinea pigs or calves cannot be applied directly to children. The food requirements of different species vary. Guinea pigs fed on the rations given to these calves would have died of malnutrition.

The only experimental results applicable to children would be experiments carried out on children themselves. As many children are already getting pasteurised milk, it does not seem impossible to have such tests carried out under the supervision of medical men, who would be able to assess the value of the results.

In the absence of such tests, the results of the above and other similar investigations seem to warrant the opinion that while pasteurisation affects the nutritive value of milk, the evil effects can be prevented, and in any case are less serious than the risk of infection with tubercle bacilli or other disease-causing bacteria liable to be present in ordinary fresh milk. The ideal milk, however, is undoubtedly fresh milk completely free from the danger of conveying infection.

In conclusion it should be stated that this investigation has no bearing on the question of the relative value of fresh and pasteurised milk for the prevention of scurvy.

Conclusions.—(1) Heat reduces the amount of soluble calcium in milk.

(2) The absorption and retention by growing animals of calcium, phosphorus and nitrogen is lower on a diet with pasteurised milk than on a similar diet with the same amount of fresh milk.

(3) The addition of a soluble calcium salt to pasteurised milk fed to growing animals increases the amount of calcium, phosphorus and nitrogen absorbed and retained.

(4) In feeding experiments with calves the rate of growth was slightly less on pasteurised milk than on fresh milk or pasteurised milk plus calcium lactate.

REFERENCES.

(1) Daniels and Loughlin, Jl. Biol. Chem., 44, 381.
(2) Magee and Harvey, Bioch. J., vol. xx, 1926.
(3) Magee and Harvey, Bioch, J., vol. xx, 1926.

FARM PESTS—BIRDS.[1]

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BIRDS AND THE GARDEN (*continued*).

Blackbirds and Thrushes.—These birds, grouped together in the thrush family by the scientist on account of their resemblances of structure, are often associated by the gardener also on account of their vicious habits in the garden. But although their feeding habits bear a family resemblance, it is a mistake to class the blackbird, the song-thrush and the missel-thrush as equals in crime. As we shall see, it is no easy matter to assess the guilt of any one of them, but of the three the most pernicious is undoubtedly the blackbird, followed in proper order by the missel-thrush and the song-thrush.

The Blackbird (*Turdus merula*) is looked upon by the fruit-grower as the bane of his existence, "the blackest of thieves." The glossy black plumage and bright yellow beak of the male bird make it conspicuous and readily recognisable, but it is sometimes forgotten that the females and the young of both sexes are brown, so that they have been confused with song-thrushes, although the pale breast of the latter always offers a sufficient distinguishing mark. Several of the blackbird's characteristics contribute to its economic importance. In the first place it is a bold bird, venturing into gardens and orchards which shyer birds avoid, and building its nest, of odd materials plastered inside with mud and lined with grass, in the hedgerows and banks alongside the very gardens which it will plunder later in the season.

In the second place it is very numerous, the general belief being that it has vastly increased in abundance during the present century. It is not easy to get comparative figures showing the relative numbers of species, but the late Capt. S. E. Brock in a census, made in 1913, covering some 16 sq. miles of Linlithgowshire, found that the song-thrush and blackbird shared the second place in the list, being outnumbered only by the house-sparrow. In the two parishes concerned Brock counted 2,600 pairs of

[1] Articles in this series, dealing with Mammal Pests, commenced in the JOURNAL in July 1922. The first article on Bird Pests appeared in January 1924.

sparrows and 1,830 pairs of each of the song-thrush and blackbird, followed by the chaffinch with 1,800 pairs.

This abundance depends on the breeding habits of the blackbird, for not only is it content with a wide diversity of nesting sites, but, beginning to breed early in the season, in March, it ordinarily rears two or more broods, each clutch containing four to six eggs. Suppose the average to be 2½ clutches each hatching four birds, the 1,830 pairs of blackbirds in the 16 sq. miles of Linlithgowshire would be represented at the end of the season by 21,960 individuals. Even were half of these to perish, the cumulative increase threatens to be enormous. Another factor tends to make for large numbers. The migrations of the blackbird are complex; in Britain there occur, in addition to individuals which are permanently resident in the country, summer visitors from the south which nest here, winter visitors which have nested in northern Europe, and birds of passage. The final result of these movements is that a large number of the birds which have reared young in this country have left it by September, while fruit is still on the trees, and their place has been more than filled by foreign individuals, which remain till the following spring.

There is not much controversy about the food of the blackbird. For nine months of the year it feeds upon insects, weed seeds and wild fruits. Beetles, "grub" or leather jackets, moth caterpillars, wireworms, earthworms, snails and slugs compose the greater part of the animal diet; the weed seeds consist largely of ragwort, chickweed, spurrey, sorrel and the like; grain also is taken, and while they are available, the fruits of hawthorn, wild rose, service tree and rowan are eaten greedily. In my town garden every autumn two or three days suffice to clear a rowan tree of its heavy crop almost before the berries have had time to redden. In these nine months then the balance is heavily weighed in favour of the blackbird.

Its condemnation rests upon its activities during July, August and September. The fruit-growers are unanimous. F. Smith wrote of Kent in 1906: "The blackbirds begin to eat fruit as soon as it colours, and spare no variety, beginning with early strawberries and going on to gooseberries, currants, raspberries, cherries, plums, damsons, apples, pears and figs. The damage they do is very considerable, as they spoil as much as they eat, or even more." C. H. Hooper (1906, p. 78) says: "The blackbird, as far as the fruit-grower is concerned, is the blackest of thieves; this handsome but sly bird appropriates strawberries, currants, cherries, gooseberries, raspberries, apples, plums and other fruit; they frequently commence an attack whilst the fruit is green, and if unmolested, they will in many cases devour the entire crop. It is, unfortunately, almost impossible to keep them from the fruit with any degree of efficiency without destroying them, for they exhibit considerable cunning in finding their way under netting, and soon learn to disregard any method of scaring which they find by experience may be braved with impunity."

From such reports and common knowledge it is evident that during about a quarter of the year the blackbird is a serious menace to fruit, but this scarcely settles the question of the

ultimate balance of its dietary. Unfortunately I know of no published statistics of its food, recorded month by month through the year in comparable numbers, which would permit of satisfactory analysis. The most extensive crop examinations in this country have been made by Dr. W. E. Collinge, but they scarcely supply all the data necessary for an independent reasoned conclusion. Thus of 89 birds whose food was recorded by him in 1913,[1] 27 had stomachs full of gooseberries. But allowing that the gooseberry season lasts a month and that every bird in that month contained nothing but gooseberries, 27 individuals in approximately one month are out of all proportion to the 89 which represent the whole year, and suggests that collecting was much more intense in the fruit season. The resulting figures, therefore, are heavily biassed against the blackbird.

THE BLACKBIRD.[2]

In a later and more complete analysis, published in 1924, and covering 285 individuals, Dr. Collinge gives a very interesting summary of his investigations by the volumetric system.[3] He finds that in town districts blackbirds eat more insect food and less fruit than they do in fruit-growing districts. Avoiding the mingling of incompatible substances like insects and vegetation, we find that in the former, a volume of 26·5 per cent. injurious insects and slugs destroyed stands against a volume of 19·5 per cent. cultivated fruit and wheat; whereas in the latter, volumes are 19·5 per cent. against 30 5 per cent. fruit. The balancing of irreconcilables is a hazardous proceeding, but it will be admitted that a volume of injurious insects is likely to do more harm than can be represented by an

[1] "Food of some British Wild Birds," p. 19.

[2] From Saunders' *Manual of British Birds*, by courtesy of Messrs. Gurney & Jackson, Edinburgh and London.

[3] "The Food and Feeding Habits of the Blackbird," in *Journal Ministry of Agriculture*, London, vol. 31, 1924.

equal volume of fruit pulp, so that in town districts the blackbird would appear to be distinctly more beneficial than harmful. Even in fruit-growing districts, so far as the statistics guide us, the debit against the blackbird throughout the year cannot much exceed the credit, if indeed it exceeds it at all.

The real difficulty lies in this, that the blackbird's credits and debits do not affect the same person; its good works benefit particularly pasture and flower garden, its evil deeds are concentrated against the fruit-grower. So that until the utopia arrives when the gainer will compensate the loser, the fruit-grower must protect his crops by destroying blackbirds, ignoring the damage thereby done to his colleagues on the farm and in the flower garden, who in all likelihood will remain unconscious of their loss. For it is obvious that no service is rendered to humanity by the blackbird in so far as it protects a fruit crop from insect pests in order itself to destroy it at a later stage.

Are all blackbirds then to be destroyed indiscriminately? Our knowledge of bird-migration has some comment to make here. Mr. Wm. Berry, an acute observer, writing in *The Scottish Naturalist* (1917, p. 127) says: "I am inclined to believe that the song-thrush or blackbird who takes a small toll of the strawberries or gooseberries in July is the individual who has been an industrious gardener all summer, but that almost before even the small-fruit season is over, many of the blackbirds and all the song-thrushes have gone from us to be seen no more for good or ill till February comes round; and that the birds seen in autumn—and for the most part in the open fields—are the migrating flocks making their way south from areas far to our north. If I am right in this, the indiscriminate slaughter of blackbirds and song-thrushes in the nesting season, under the belief that the fruit crops will thereby be conserved, may do more harm than good to these very crops, and this even although fruit may form the bulk of the crop contents of selected individuals killed for examination in the fruit season. The fruit diet is noticed at once, but the unostentatious consumption of countless hosts of grubs and insects, especially in the early mornings, is much less readily observed."

The Missel-Thrush or Storm-Cock (*Turdus viscivorus*).—This bird is sometimes confused with the song-thrush, an unfortunate confusion, which may lead to the condemnation of an innocent; for, like as the birds may be in appearance and general habit, their behaviour in the fruit garden differs. To distinguish them, however, is not difficult. The missel-thrush is a relatively large bird, 11 inches long, the song-thrush is but 8½ to 9 inches; the plumage of the missel-thrush is ashy brown above, the under parts buffish white with rows of very definite oval dark brown spots passing down the breast and along the belly, whereas the upper parts of a song-thrush are olive brown, the under parts almost white shading into a reddish yellow on the flanks and throat, and the spots, smaller in size and less definite in outline, are confined to the throat, breast and flanks. The song of the missel-thrush is stronger but less varied than that of the song-thrush, and a very characteristic note is a harsh churr produced when the bird is flying or alarmed.

The missel-thrush is much less common as a resident bird in Britain than the song-thrush. Brock's unpublished census of the 16 square miles in the parishes of Kirkliston and Ecclesmachen in Linlithgowshire record only 150 pairs of the former as against 1,830 pairs of the latter. But in autumn considerable numbers reach this country from the continent, some remaining through the winter while others continue their migration to Southern Europe and Northern Africa. These birds reappear in the British Isles on their return journey from February till April. A large nest, generally in the fork of a tree, is built by resident birds, sometimes as early as February, and four or five greenish eggs with spots of purple-brown are laid. Often a second brood is reared.

For eight or nine months of the year the missel-thrush performs work of value to man. It devours caterpillars and other insect larvæ, beetles, earthworms, and, like the song-thrush, it smashes snails upon a stone or "anvil," so that it may reach the dainty concealed in the shell. During these months also it feeds upon berries when they can be obtained, yew, ivy, juniper, hips and haws, service tree, and especially rowan. It is generally condemned on account of the remaining three or four months, when, in some districts, it turns to the fruit garden. According to Hooper (p. 79), "in Kent it is considered one of the worst birds with fruit, specially troublesome with cherries and soft fruit; it persistently eats pears, apples, plums, damsons and many kinds of berries; it is fond of black currants, which other birds avoid." Smith,[1] on the other hand, while he regards them as almost as bad as blackbirds, says that they are "not so troublesome with the apples."

Dr. W. E. Collinge[2] has made an analysis of the food of missel-thrushes, which affords a very interesting glimpse at the components of their dietary. According to these figures vegetable matter makes up almost half the volume of the food—45 per cent. Of this, 24 per cent. consists of wild fruits and seeds, 4·5 per cent. miscellaneous vegetable matter, and only 16·5 per cent. cultivated fruits. The remaining 55 per cent. of bulk is animal matter, distributed in percentages as follows:—beetles and their larvæ 23, caterpillars 5, leather-jackets 2·5, slugs and snails 3·5, spiders, millepedes, etc. 1·5, or in all 35·5 per cent. of injurious creatures, against which may be set the destruction of 4·5 per cent. beneficial insects. Earthworms form a high average in these 52 crops, 14 per cent., but in April and May they made up almost a quarter of the bulk of the food.

In short, then, against the destruction of 16·5 per cent. of cultivated fruit must be set the destruction of twice as great a bulk of injurious insects. Undoubtedly, over all, the missel-thrush does far more good than harm, but the difficulty is, as in the case of the blackbird, that the benefits and injuries do not fall upon the same person. The fruit grower does most of the suffering, the farmer and gardener share the advantages. The fruit-grower, therefore, can hardly be blamed if he condemns the missel-thrush and does his best to reduce its numbers in his neighbourhood, but it must

[1] "The Fruit Grower and the Birds," 1906.
[2] *Journal of the Board of Agriculture*, Sept. 1918, p. 672.

be recognised that he does so to the loss of his agricultural neighbours. It is not everywhere, however, that this bird occurs in sufficient numbers to be regarded as a serious pest, even to fruit. The conditions in Kent and in the southern portions of England, where British-breeding missel-thrushes as well as autumn visitors and birds of passage tend to concentrate during the autumn and winter, are unusual, and find little counterpart in northern fruit districts.

The Song-Thrush or Mavis (*Turdus musicus*).—As we have already seen, the song-thrush is one of the most common of our birds, sharing with the blackbird a place only second to the house-sparrow. In addition to the features which have been indicated as distinguishing the song-thrush from the missel-thrush, the former may be recognised in flight by the bright buff-coloured feathers in the angle of the outspread wing. In the missel-thrush these are white. The song-thrush is less exclusive in the choice of a nesting site than its relative, a tree, bush, hedge, bank, outhouse, hole in a wall, or the ground affording a suitable place. The nest, always lined by a cup composed of mud mixed with rotten wood and horses' dung, and smoothed by the turning of the bird while the mixture is soft, is built in March, and four or five very blue eggs with black spots are laid. Two or three broods are reared in a season.

In a general way the food of the song-thrush bears a close resemblance to that of the blackbird and missel-thrush, with a slightly different emphasis upon the various items. During nine months of the year the bird is almost wholly beneficial, feeding upon insects and their larvæ, beetles, wireworms and leather-jackets, slugs and snails, earthworms, and wild berries in their season, but during the other three months it takes its toll of fruit. It shows little traits of character, however, which make it less obnoxious than the blackbird. The blackbird neglects the slug and snail portion of its dietary when more attractive fare offers in the summer and early autumn, but the song-thrush sticks to his snails throughout, and snails are serious pests which man unaided finds it hard to counter. Again blackbirds can hardly conceal the fact that they prefer fruit, and will seek it even while other food is abundant, but the song-thrush is less strongly addicted, and its most serious damage is done during dry weather when earthworms and snails are hard to obtain and the need for fluid, in any form, becomes insistent.

Dr. Collinge's analysis of the food of 84 adult song-thrushes [1] would indicate that the food and food-proportions are remarkably like those of the missel-thrush, though the general impression is that the latter is more destructive where it occurs. Injurious insects formed 32 per cent. of the bulk, distributed amongst beetles and beetle larvæ 24·5, lepidopterous larvæ 4, leather-jackets and crane flies 2·5, and miscellaneous insects 1. In addition, slugs and snails form 5 per cent. and earthworms 15. Of the 43 per cent. of vegetable matter, 26·5 per cent. represents wild fruits and seeds, 1·5 miscellaneous, and only 15 per cent. cultivated fruits. Moreover the food of 38 nestling song-thrushes proved to be composed of injurious insects to the extent of 90·5 per cent. of its bulk.

[1] *Journal of the Board of Agriculture*, March 1919, p. 1457.

It is clear that throughout the year the song-thrush far more than compensates for the damage done in summer in the fruit-garden. It is unfortunate for its own sake that, like missel-thrush and blackbird, it pays most of the compensation to the wrong person.

The thrush family illustrates that gradual change in feeding habits which extensive cultivation has induced in several birds. It is said that half-a-century ago the damage done by birds to the grower was insignificant, and O. V. Aplin in a letter quoted by Hooper in 1906 records how, in the ten years preceding his writing, blackbirds having begun on bush fruit had proceeded to plums: "the damage done to plums is a new thing, and is now most serious." While the missel-thrush has followed suit, the song-thrush has adhered more closely to its former habits.

The Starling.—The starling, also, is one of the birds whose feeding habits have been undergoing a change for the worse. The effect of its increasing numbers upon the grain crop has already been discussed (p. 43), but the same increase has brought it into disrepute in the garden. Its very numbers constitute a threat, for when the autumn immigrants arrive in their hordes they frequently congregate in shrubberies in thousands, as happened even in the centre of Edinburgh, in the Royal Botanic Garden, in the autumn of 1925.[1] There are many records of destruction caused by such roosting in shrubs; not only are the shrubs disfigured, but frequently large branches are broken by the weight of the birds, shrubs may deteriorate and die because of the filth deposited on them, and in some cases the stench of the roost has become unbearable.

This kind of damage, however, is limited in extent; but wherever the starling has multiplied it has in recent years been convicted of fruit-destruction. Introduced into New York City in 1890, by 1915 it was distributed locally over most of Massachusetts, and E. H. Forbush, in describing its activities there,[2] states that the vegetable food consisted very largely of fruit, birds collected during the cherry season containing an average of 56·17 per cent. of the skin, pulp and stones of cultivated cherries. So also in Victoria, to which it has been introduced from Europe, French found that "there can be no doubt about the starling being a most pernicious enemy to the fruit-grower and viticulturist in this State."[3]

The experience of fruit-growers as well as examinations of the food-content of starlings in this country give equally convincing results. Hooper (1906, p. 78) says "the starling, though an excellent bird on grassland and valuable in woods, is very severe and persistent on fruit, especially cherries and damsons, and, as men say, 'will not take no for an answer,' and often will not leave the tree until actually shot. Together with blackbirds and thrushes it attacks strawberries. Mr. George Abbey informs me that at Eltham it destroyed also pears, apples and plums. They swoop in

[1] J. Kirke Nash in *Scottish Naturalist*, 1926, p. 67.

[2] The Commonwealth of Massachusetts, State Board of Agriculture, Circular No. 45, February 1916.

[3] C. French, "A Handbook of the Destructive Insects of Victoria," Melbourne, 1890–1911.

flocks on the raspberry fields at Swanley, in Kent, especially in hot weather."

Owing to the fact that Theobald and M'Gowan[1] received few birds during the fruit season, their statistics ignore this branch of the starling's activities, but Collinge's examination of 368 adults[2] showed that almost half the food consisted of vegetable matter, 15·5 per cent. of the total bulk being made up of cultivated fruits. Against this and its consumption of 20·5 per cent. of cereals must be set its destruction of injurious insects 26·5 per cent., of snails and slugs 6·5 per cent., and of millepedes 1 per cent. Of 40 nestlings examined the food consisted to 89·0 per cent. of injurious insects.

The damage done to autumn fruit is almost wholly due to immigrants from continental Europe. We have already pointed out that little harm can result in Britain from the destruction of these autumn marauders, provided it is realised that the birds killed in the fruit-garden would probably have spent the remainder of their five months' sojourn in this country hunting out and destroying insects mostly injurious. The argument will fall lightly upon the fruit-grower, for while he suffers most he reaps little of the benefit from the destruction of ground pests.

THE NUTRITIVE REQUIREMENTS OF POULTRY.

VII.—NOTE ON GROWTH IN CHICKENS.

(Preliminary Communication.)

J. B. Orr, G. Scott Robertson, Miss A. Kinross, Miss G. Lewis, and Miss H. Newbiggin.

THE previous articles on Nutrition of Poultry dealt chiefly with the result of feeding experiments designed to test the value of various rations for egg production. While these egg-laying tests were being carried out, experiments of a similar nature were done on growth of chickens. Some of the data on chicken-rearing which has accumulated may be of interest to the increasing number of poultry keepers who are making observations or in some cases carrying out experiments on this important branch of the poultry industry. It was decided, therefore, to publish this preliminary note giving an indication of the lines along which work is being done, and also of the nature of the results being obtained.

The two substances needed in largest amounts as constructive material for the growth of flesh and bone are proteins and mineral salts. For mammals the best source of these is milk, the foodstuff provided by nature to supply the dietary need of the suckling. Many of the substances required for flesh and bone formation are the same for both bird and mammal. It might be expected, therefore, that rations containing milk would give good results when fed to chickens, as indeed is known to all poultry keepers.

[1] *Supplement to the Journal of the Board of Agriculture*, May 1916.
[2] *Journal of the Board of Agriculture*, March 1919, p. 1447.

There is, however, little definite information based on experimental results to show the extent to which milk improves ordinary chicken rations, and even less to indicate the relative values of the different constituents for promoting growth. A series of experiments was therefore carried out to show the increased rate of growth produced by the addition of whole milk to ordinary chicken rations, and also to see what proportion of this increase could be obtained with either separated milk or protein plus mineral salts. Groups of chickens three or four days old were fed on a ration consisting of cereals and cereal products. One group was given this "basal" ration with no addition. To the ration of each of the other groups there was added either whole milk or separated milk, or a substance rich in proteins and mineral salts.

In each experiment the chickens were closely related and from the same hatching, so that at the beginning of the test the groups were as similar as could be arranged. The birds were kept under good conditions with a run on pasture. In all the tests except No. II the cockerels were taken out as soon as the sex of all the birds could be determined. There are therefore two experimental periods, the first, A, relating to the "mixed group," and the second, B, to the "pullets only." In experiment II there were 40 birds in each group; in the others there were from 17 to 19 in each.

Table I shows the effect of the addition of milk and compares the effect of whole milk and separated milk.

TABLE I.

Effect of Milk.

EXPERIMENT.	No. of Days.	Average Gain in Weight per Bird in Grammes.		
		No Milk.	Whole Milk *ad lib.*	Separated Milk *ad lib.*
I. Mixed	98	1,071	1,251	1,279
II A. Mixed	42	152	320	354
II B. Pullets only	49	518	679	691
III A. Mixed	50	159	494	...
III B. Pullets only	40	236	488	...
IV. Mixed	126	1,239	1,852	...

In every case the groups receiving milk grew faster than those receiving no milk. The gain in weight of those receiving separated milk was even greater than that in those receiving whole milk. In a previous paper in this Journal (July 1924) it was shown that the addition of Cod Liver Oil or Olive Oil to the ration of chicks kept on grass runs did not increase the rate of growth. On the whole the rate of growth of those receiving the oil was less than that of those receiving no oil. It is evident that excess of oil or fat in the food of chickens may be harmful. In any case it seems clear that the beneficial effect of milk on chickens is not due to the fat of the milk.

In Table II the gains in weight of those receiving milk are compared with that of those receiving meat and bone meal. The number of birds and the length of experiment are as stated in Table I, two columns of which are repeated here for convenience in comparing figures.

TABLE II.

Milk v. *Bone and Meat Meal.*

EXPERIMENT.	Average Gains in Weight per Bird in Grammes.		
	Basal Ration only.	Basal Ration plus Whole Milk.	Basal Ration plus 10% Bone and Meat Meal.
I.	1,071	1,251	1,234
II A.	152	320	242
II B.	518	679	641
III A.	159	494	411
III B.	236	488	441

The rate of growth on the ration containing the meat and bone meal was definitely greater than that on the basal ration without any addition. It was not so great, however, as that on the ration containing milk *ad lib.*

It is interesting to note that in Experiments II and III the increase in rate of growth due to milk or to meat and bone meal is greater in period A, i.e. in the earlier stages of growth, than in the later period B.

In a third group of experiments the effects of rate of growth of (*a*) linseed meal, a substance rich in a vegetable protein, and (*b*) linseed meal and mineral salts, are compared with the effect of whole milk. The test was continued for 18 weeks.

TABLE III.

Whole Milk v. *Vegetable Protein and Mineral Salts.*

Basal Ration only.	Basal Ration plus 5% Linseed Meal.	Basal Ration plus 5% Linseed Meal to a 1·67% Mineral Mixture.	Basal Ration plus Whole Milk *ad lib.*
1,239	1,255	1,509	1,852

The addition of the linseed meal alone had little effect. The linseed meal plus the mineral salts increased the rate of growth, but the increase was less than half that produced by milk. There was less difference between the milk and meat and bone meal (see Table II) than between milk and linseed meal plus mineral salts. The animal protein and mineral salts are evidently of more value for growth than the vegetable protein and mineral mixture used.

As it is hoped in the near future to deal in greater detail with the groups of experiments of which these are representative, it will be sufficient here to state some of the general conclusions which may be drawn from these preliminary experiments:—

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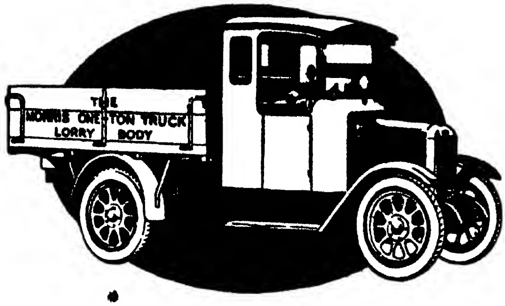

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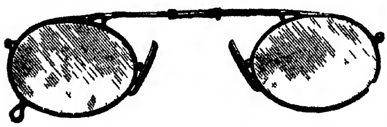

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(1) The addition of milk to a cereal ration fed to chickens is accompanied by a markedly increased rate of growth.

(2) Separated milk is as valuable for promoting growth in chickens as whole milk.

(3) Chickens, especially during the earlier stages of growth, require a higher proportion of protein and certain mineral salts than are contained in rations composed of cereals and cereal products. In the present state of our knowledge it would seem that the best source of these extra proteins and salts is milk, but beneficial results may also be obtained from the use of other proteins and artificial mineral mixtures.

THIS article has been contributed by Mr. T. Milne, Kellas Poultry Farm, Kingennie, Forfarshire.

Poultry Farming on a Ten Acre Small Holding.

Five years ago I obtained possession of a ten acre holding on the estate of Gagie with the object of running it as a poultry farm. I had previously undergone a year's course of instruction at the West of Scotland Agricultural College, Kilmarnock, and started with a capital of only £600. The holding lies on a gentle southern slope, sheltered from east winds by a fir plantation, and is ideally situated for poultry keeping.

In August 1921 I began building my first poultry houses on a neighbouring holding, preparatory to moving in in November. The original stock of 50 White Leghorn hens and the same number of pullets I bought from Kilmarnock College.

That winter I built five small brooder houses, 6 ft. by 3½ ft., each to hold 100 chicks. I had already decided on the "small unit" method, to which I still adhere. I know of no sound reason why any poultry farmer should hazard over 10 per cent. of his chicks at one time to an outbreak of disease or fire. I have had both on this place, and thanks to using the "small unit" my losses have been negligible.

In the spring of 1922 two 250 egg Gloucester Incubators were installed and hatching was commenced. From then till now I have had a steady increase every year, with only occasional small set backs due mostly to my lack of knowledge and experience. For five years the place has given me an ever-increasing income and at the same time built itself up. I have never borrowed a penny, and have relied solely on my returns for the gradual extension of the plant.

To-day my stock numbers roughly 1000, composed of 700 White Leghorns, 200 Rhode Island Reds and 100 White Wyandottes. Half of those are pullets which will be in full lay by November. My incubating capacity is 1500.

The day-old chick trade has increased from 200 in 1922 to over 1500 this season, and £3 would cover the advertising expenses for the whole period. Roughly 90 per cent. of those chicks are reared to maturity. Not a single chick has been lost through leg weakness, although this sometimes appears in early spring when the weather has forced me to keep the chicks inside. As soon as I see the first chicks on their hocks, I let them out on the grass and in a few days they are all right.

In my first two years I found my White Leghorn chicks more difficult to rear than my Rhodes and Wyandottes.

This was probably due to close breeding. I outcrossed with a Leghorn cockerel and W. Orpington hen, which proved a lucky hit, for the progeny included the top hen for the year. Gradually her blood has been infused into the stock, and I can trace her still in my most prolific and largest birds. Other new blood has been introduced, and my Leghorn chicks are now as hardy as my Rhodes and Wyandottes.

As a prevention against B.W.D., every egg is methylated before being put into the incubator, and there has not been a single case of the disease since this method was adopted four years ago.

Housing.—My latest and best laying houses are 20 ft. by 12 ft. and are of the lean-to type. Into these (probably to the horror of the poultry experts who may read this) 100 birds are crammed. Perches and dropping boards are at the back. Over these a ventilation shaft carries the air to the centre of the house. A 3-in. opening along the front completes the air circuit. Inside the house, 6 inches behind this opening, a board set at an angle catches direct winds and forces them back on to the front of the house, where they are disseminated before reaching the floor. Large outer hoods I find useless. When a direct wind strikes the front of the house it spreads in every direction in its attempt to pass. The upward current is caught by the hood and forced into the house. It thus frustrates the very purpose for which it was put on.

The front window, 2 ft. deep, extends the length of the house and is 18 in. from the floor. This setting prevents the rays of the high summer sun from entering direct, and allows the low winter sun full scope. Above the glass are two doors, 3 ft. square, which are only closed when rain is being driven in from the south. This admission of direct sunlight I consider very important, and on frosty mornings when the birds are kept in, these doors allow them all the benefits of the sharp clear atmosphere outside without its drawbacks.

Trap-nests after my own ideas are installed in all the houses and birds are trapped during the whole of their pullet year

Ten houses 7 ft. by 5 ft. do duty as single breeding pens. As soon as hatching ceases, the breeders are turned out among the layers and these houses are used as chicken houses.

Feeding.—This is entirely on the dry mash system. Chicks get their first feed of chick seed when forty-eight hours old. Next day the dry mash hopper is put in. Three times a day they are given water and a handful of seed and the rest they get from their hoppers. They thrive splendidly.

The chick seed (Tom Newman's Mixture) is bought mixed. The mash is made up on the place. For chicks up to six weeks the mixture is :—

Broad bran	3	parts (by weight)
Fine white thirds	3	,,
Maize meal	1	,,
Sussex ground oats	2	,,
Meat and bone (or fish) meal ...	½	,,
Linseed meal	½	,,

At six weeks they go on to :—

Broad bran	3 parts
Fine white thirds	3 „
Maize meal	3 „
Sussex ground oats	3 „
Meat and bone (or fish) meal	1 „

The amount of Sussex ground oats is gradually reduced until after twelve weeks it is cut out altogether as being too expensive. Wheat, oats, and kibbled maize are used in place of the dearer chick seed as soon as ever the chicks are able to eat them.

Last season I tried another well-known chick mash and my birds were a month late in maturing. The experiment cost me £30 in loss of eggs. My fixed method of feeding is now as above.

Layers and breeders get 1 oz. of grain in the morning and as much as they can eat at night. In winter the morning feed is well raked into the litter. The evening grain feed I intend giving this year in troughs, because if darkness falls before the birds have filled their crops, a drop in eggs takes place two days later. Equal quantities of wheat, oats and kibbled maize are used in winter. Up to half the maize (but no more) is cut out in summer. I formerly cut it out entirely, but in June eggs always began to be small. Normal sized eggs were restored by reintroducing the maize.

Laying mashes may vary considerably. The following have been found simple and satisfactory.

	Winter Mash.	*Summer Mash.*
Broad bran	½	1
Fine white thirds	1½	1½
Maize meal	2	1
Meat and bone meal	¾	½
Soya bean meal	¼	¼

Breeding.—Last winter eight single breeding pens were added to the two already here, as a result of my experience two years ago when I mated up the two single breeding pens I had. All the birds had similar records, i.e. round about 200 eggs. Both cockerels were from the best blood in Britain. No. 1 pen gave (as I expected) daughters whose records range from 160 to 260. No. 2 pen gave not a single pullet worth keeping. Not one averaged 140 eggs.

I had a repetition of the same thing last season. Every cockerel is now tested by his daughter's records. All breeding hens are selected for size and vigour. They are then classed as follows :—

Year record,	e.g.	200 and over.
Maturing period,	„	180 to 210 days.
Size of egg,	„	average over 2¼ oz.
Winter record,	„	over 30 eggs, Oct. 15 to Jan. 15.
Autumn record,	„	still laying Sept. 30.

Such a hen as in the example would be first grade.

Five years only brings one to the end of his apprenticeship in breeding; the work is fascinating, and it is here that the poultry farming battle is lost or won.

The results of this season's matings are just beginning to be apparent in the young pullets which have commenced laying, and they show splendid promise for the coming season. I can already see one or two failures but the majority are good.

Manure.—Three-quarters of an acre is laid out in raspberries and black currants. This acreage absorbs all our manure, and the sale of fruit adds some £40 to the year's profits.

Sales.—The retail sale of eggs is rapidly increasing simply by customers telling their friends. A small car is used to convey these eggs round.

Records.—In addition to the ordinary egg charts and stud book, every day's egg yield is recorded on a graph. Thus one year's results are compared with another, and one can see at a glance if the egg yield drops below normal. The cause has then to be found and the balance restored. Without the graph one might be tempted to class the decline as "seasonal," or it might not even be noticed, and the maximum output and maximum profit would never be reached.

Carrot Fly on Parsley.

A SMALL field experiment was carried out with the assistance of Mr. Robert Scarlett at Inveresk on the control of Carrot Fly on parsley. This fly is exceedingly troublesome on the carrot, but it is not always realised that it often causes almost total loss of crop with parsley, and especially with field-grown parsley. The parsley is attacked when young in the end of May or June, and the grub does not bury itself in the root, as the root is too small, but eats small channels in the root tissue, which turns rusty-red. The presence of the fly is indicated by the yellow, dwarfed, sickly appearance of the young plants, and if they are carefully taken up, the little white grubs can be found, often hanging on with their heads buried in the tissue of the root.

Some rows of parsley at varying intervals were chosen with intervening untreated rows as control. The rest of the field being untreated also acted as control. A length of 30 feet of drill was taken. To this was applied 1 gallon of a 1/1000 solution of corrosive sublimate on May 17th, 1926. At this time the parsley was about 1 inch high. The treatment was repeated on May 27.

The solution was made as follows. A firm of druggists, at the writer's request, made up a set of capsules of corrosive sublimate (mercuric chloride) so treated with a very little hydrochloric acid that they would immediately melt on being put in water, and of such size that 1 capsule in 1 gallon of water should make 1/1000 solution. They were also so stained that the water was turned purple. As corrosive sublimate is a very powerful poison, it seemed safer to have it in tabloids or capsules, to ensure that the solution should be of exactly the right strength; the colouring of the solution was intended to act as a danger signal. In pouring the solution on the plants a cork in the spout of the can was used instead of a

A B

Parsley treated with $\frac{1}{1000}$ Corrosive Sublimate against Carrot Fly.

A—Treated. B, C—Untreated.

rose, with a hole in the cork, cut of such a size that it was easy to pour the gallon over the 30 feet evenly.

In July the untreated part of the field was so badly affected that it was ploughed in, while the treated rows stood out vividly as a healthy, good crop. The control from a distance was striking and, as the grower said, showed all the difference between success and failure.

Notes from Craibstone.

Standing Power of Oats.—Since the introduction of Wild White Clover, farmers throughout the North of Scotland have been finding increasing difficulty with the lodging of the oat crop after lea. To such an extent has this become the case that some of them, although recognising the great value of Wild White in the pastures, have been seriously considering cutting this seed out of their grass mixture, because they consider that a moderate crop, well ripened and standing well, pays better in the end than a very heavy crop that is badly lodged and difficult to handle.

During the past few years close observation has been made on different varieties at Craibstone with a view to finding if any will really stand well under varying weather conditions, and experiments have also been carried out with a view to finding if anything can be done to strengthen the straw and prevent lodging.

As regards the varieties, it is well known that straw producers such as Potato, Scots Berlie and Sandy, are more liable to lodge than the bigger grained varieties, but it cannot yet be said that one has been found that can be depended upon to stand well every year and at the same time produce a satisfactory crop. As an example, in 1925 all the later maturing varieties, including Victory, Record, King, Fortuna and Abundance, were laid, while early varieties like Yielder, Superb, Beseler's Prolific, Garton's Early and a Dutch variety, Mansholt, were standing. In contradistinction to this, in the past season the earlier maturing varieties were badly laid early in the season, whereas the majority of the later varieties which we have mentioned were still standing, although later on they also were laid.

It would seem that the cause of the lodging is a very rapid period of growth in the variety followed immediately by a rather heavy rainfall. The time of this period of growth varies with the season. Consequently, any particular variety will be affected in different seasons in opposite directions as regards standing power, and, therefore, the earliness or lateness of the variety, more than any inherent strength of the straw naturally, will determine whether it will stand well or not. Should, however, the rapid period of growth be followed by a dry spell, the stems would seem to regain their strength, and even when rain falls later on the lodging will at least not be so bad.

As a general rule, however, it has been found that, in the majority of seasons, early varieties do stand better than the later varieties. Every effort, therefore, should be made to increase the earliness in addition to using other methods for strengthening the straw. For example, it has invariably been found here that a

variety sown early in the season stands better than the same variety sown much later. One season where Victory was sown at two different times in the same field at an interval of three weeks between the sowings, the early sown was about 9 inches longer in the straw, and yet was standing well while the late sown was badly laid at the end of the season. Very often, too, the advantage of this early sowing is that the crop is ready for harvesting sooner in the season, and there is a greater likelihood of escaping adverse weather conditions under which the crop would otherwise be laid.

A good deal can also be done to increase the standing power by using as thin a seeding as the soil and district will otherwise permit. Here, again, very great differences have been noted in the experiments at Craibstone in the standing power of thick-seeded as compared with thin-seeded oats. In several trials where Victory was used the thick seeding went down very much sooner than the thinner seeding, the seedings in question varying from 8 bushels to 5 bushels per acre. The thick seeding undoubtedly leads to a later maturing crop, but provided the seed is sown early, less difference will be found in this connection. It has also been noted that the plots seeded with large seeds rather than with a mixture of large and small seeds have always stood better and have always ripened more uniformly. The use of well graded seed, therefore, will contribute to the standing power as well as prove a saving in seed.

As regards manuring, where a dense turf rich in clover is ploughed in, no manures, of course, would be applied. Where, however, the land is in poorer condition and the sod is not so rich, it has been found that complete manures have given better results as regards standing power than incomplete manures. Many farmers are in the habit of withholding sulphate of ammonia from mixtures applied to lea on the poorest classes of land. The experiments at Craibstone, however, have indicated that sulphate of ammonia, even from the point of view of standing power, is beneficial under these circumstances, when it was used in moderate quantity along with phosphates and potash. Probably this is due, in part, to the fact that the plots to which the complete manures were applied were earlier Contrary to what is generally stated, it has not been found that phosphates or potash, used separately or in combination, have had any marked beneficial effect on the standing power or earliness.

The effect of the application of lime has also been observed, and it has been found in all cases that on the plots to which lime was applied the crop was later and lodged worse than on the no-lime plots. Salt has also been tried in different years and in different quantities, but showed no apparent effect.

On very rich lands, and where the turf is very rich in Wild White Clover, it would seem at the present time to be practically impossible to get a standing crop even under ordinary weather conditions. In such circumstances, the only alternative is to alter the rotation by taking a potato or other "root" crop after the lea instead of oats. The oat crop taken after this root crop will not be so liable to lodge, and an excellent potato or root crop can be grown after lea at a comparatively small expenditure so far as

manuring is concerned. In some cases mashlum for silage purposes is taken after lea, and then the oat crop after that is not so liable to lodge.

THE following article has been contributed by Sir Jas. Wilson, K.C.S.I.:—

Farm Wages in Scotland in Summer 1926.

In a statement recently issued by the Board of Agriculture giving the rates of wages for farm labour at present prevalent in Scotland, they have, in calculating the cash value of the allowances given in addition to the cash wage, adopted for the whole country the following values:—meal, 17*s.* 6*d.* per cwt.; milk, 1*s.* per gallon; potatoes, £3 per ton; house, £6 per annum; coal, 35*s.* per ton; board and lodging for single men, 14*s.* per week; bothy accommodation, with attendance, £9 per annum, without attendance, £6 per annum. These values are the same as were adopted a year ago, except that the value placed on oatmeal has been reduced from 20*s.* per cwt. to 17*s.* 6*d.*, and the value placed upon potatoes from £4 per ton to £3 per ton. The reduction in the estimated cash value of oatmeal would mean, in the case of a man who gets 65 stones of oatmeal per annum, a reduction of about 5*d.* a week, and the reduction made for potatoes would mean, in the case of a man who gets a ton of potatoes in the year, a reduction of about 5*d.* a week in the valuation of his allowances, even if their quantity has not been changed. Many men get much less oatmeal and potatoes than this, and the reduction in the estimated value of the allowances due to this cause alone must for the whole country be well below 1*s.* a week.

As regards married men, the arithmetical average of the statistics now given by the Board work out as follows for all the counties put together.

Average Weekly Earnings of Married Men.

	In Summer 1925.			In Winter 1925 26.			In Summer 1926.		
	Cash.	Allowances.	Total.	Cash.	Allowances.	Total.	Cash.	Allowances.	Total.
	s. *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
Ploughmen .	29 11	8 5	38 4	30 3	8 1	38 4	30 2	7 10	38 0
Cattlemen .	30 0	9 1	39 1	31 5	8 5	39 10	29 9	9 0	38 9
Shepherds .	30 0	9 5	39 5	30 8	9 0	39 8	28 11	9 5	38 4

These averages are, from the nature of the case, only rough approximations to the truth, but, taking them as they stand, they indicate, as compared with summer 1925, a small increase in the cash wages of ploughmen, a small decrease in those of cattlemen, and a decrease of about 1*s.* a week in the cash wages of shepherds. There is a decrease in the value placed upon the allowances of ploughmen (accounted for above), and on the whole the total value of the weekly earnings of the married ploughmen and cattlemen works out at much the same this summer as last, while that

of the married shepherds is down by about 1*s.* a week. There is no great difference between the average cash wages of the three classes, or between the average values of their total earnings.

Married Ploughmen.—In the eastern part of the central industrial area, which comprises Fife, South Forfar and the Lowland part of Perthshire, the married ploughmen are generally engaged for a year from Martinmas, and there no change was made in their cash wages at last Whitsunday; but in the rest of Scotland new bargains are made with them every Whitsunday, generally for a year, except in the Lower Clyde Valley in the neighbourhood of Glasgow, where six months' engagements are the rule. The result of these arrangements is at present approximately as follows. (I have taken into account newspaper reports of the results of the hiring fairs, and rounded off the figures, which can only be roughly approximate.)

Average Weekly Earnings of Ordinary Married Ploughmen in Summer 1926.

COUNTY OR DISTRICT.	In Summer 1925.			In Summer 1926.		
	Cash.	Allowances.	Total.	Cash.	Allowances.	Total.
	s.	*s.*	*s.*	*s.*	*s.*	*s.*
Wigtown	24	15	39	24	14	38
Kirkcudbright	34	4	38	34	4	38
Dumfries	33	4	37	33	4	37
Selkirk	33	5	38	33	5	38
Roxburgh	33	5	38	33	5	38
Berwick	35	6	41	35	5	40
Peebles	35	5	40	35	6	41
East Lothian	37	5	42	36	5	41
Midlothian	38	5	43	38	5	43
West Lothian	38	5	43	38	5	43
Stirling	40	3	43	40	3	43
Dumbarton (Lower Clyde Valley)	40	4	44	40	4	44
Lanark, N.W. (Lower Clyde Valley)	40	4	44	40	4	44
Renfrew (Lower Clyde Valley)	40	4	44	40	4	44
Ayr (North)	38	5	43	37	5	42
Ayr (South)	37	4	41	35	4	39
Lanark (S.E.)	36	4	40	36	4	40
Clackmannan	40	1	41	40	1	41
Fife (S.W.)	40	1	41	40	1	41
Fife (N.E.)	30	12	42	29	11	40
Kinross	29	11	40	29	10	39
Perth (S.E.)	29	11	40	29	10	39
Perth (Central)	26	11	37	27	10	37
Forfar (S.W.)	31	11	42	31	10	41
Forfar (N.E.)	31	11	42	29	10	39
Kincardine	29	11	40	30	10	40
Aberdeen (East)	26	11	37	26	10	36
Aberdeen (N.E.)	24	11	35	24	10	34
Aberdeen (Central)	23	11	34	22	10	32
Aberdeen (S.W.)	23	11	34	26	10	36
Aberdeen (N.W.)	23	11	34	23	10	33
Banff (N.E.)	25	11	36	24	10	34
Moray	26	11	37	26	9	35
Nairn	24	12	36	23	11	34
Inverness (East)	23	11	34	23	11	34
Ross (East)	24	13	37	24	12	36
Sutherland (East)	18	13	31	18	12	30
Caithness	16	15	31	16	15	31

The arithmetical average for this summer for these 38 Counties and parts of Counties is 38*s.* 3*d.* (cash 30*s.* 8*d.*, allowances 7*s.* 7*d.*), which may be compared with my estimate for summer 1925 of 38*s.* 11*d.* (cash 30*s.* 10*d.*, allowances 8*s.* 1*d.*), an average decrease of about 8*d.* a week, due chiefly to the reduced valuation put this year on oatmeal and potatoes. As the numbers of married ploughmen who draw earnings in excess of the average must be greater than that of the men who draw less, it may still be assumed that at present the average value of the earnings of an ordinary married ploughman in Scotland is about 39*s.* a week, as compared with 39*s.* last summer, and with 22*s.* in summer 1914, an increase of about 77 per cent. above the pre-war level. According to the *Labour Gazette* the cost of living is now (July 1926) 70 per cent. above what it was in July 1914, so that the average married ploughman is still in a position to maintain his family at the standard of comfort they had attained immediately before the outbreak of war.

Practically everywhere in Scotland the married ploughman is provided with a house and garden, free of rent and rates, and with certain allowances, such as oatmeal, potatoes, milk, coal and firewood, which vary considerably from one part of the country to another and even sometimes from man to man. Curiously enough, in Wigtown the custom still is to pay a large proportion of the weekly earnings in kind, valued at 14*s.* a week, although in the other counties south of the Forth and Clyde the allowances in kind are only of the value of from 4*s.* to 6*s.* a week and the cash wages proportionately higher, while north of that line the allowances in kind are again much larger and vary in value from 9*s.* up to as much as 15*s.* a week, with a corresponding reduction in the cash wage. Including cash and allowances the average weekly earnings of a married ploughman in the southern counties of Scotland are from 37*s.* to 38*s.*; in the south-eastern counties, including the Lothians, they are from 40*s.* to 43*s.*; in the Lower Clyde Valley, 44*s.*; in the rest of the central industrial area from 40*s.* to 42*s.*; and north of Kincardine they gradually become less in value, until in Caithness they amount only to about 31*s.* In the West Highlands the number of married ploughmen employed is comparatively small, and statistics regarding their wages and allowances vary considerably and hardly admit of being averaged. They are reported as amounting to 41*s.* a week in the Lewis, 44*s.* 10*d.* a week in Central Argyll, and 40*s.* a week in Kintyre.

Single Ploughmen.—The wages paid to single men vary greatly according to their varying experience and capacity. In the South-Eastern Counties, where the single ploughmen are generally engaged for a year from Whitsunday, get no allowances, and live with their parents or relatives, the reporters give the average cash wages at about 34*s.* 7*d.* per week, or much the same as last summer, varying from 32*s.* in Roxburgh and Selkirk to 37*s.* in the Lothians. In the rest of Scotland the single men generally make a new bargain every six months. In the Lower Clyde Valley and North Ayr the single ploughmen are reported as getting on the average about 21*s.* a week (as compared with 23*s.* last summer), besides board and lodging valued at 14*s.* The decrease in the cash wage may be due to the effect of unemployment in the shipbuilding and

engineering industries, to the stoppage of work in the mines, and to a consequent increase in the supply of men anxious for employment on the farms. In Forfar, East Perth and Fife, where the single men usually live in bothies and get fire and light and allowances of oatmeal and milk, which may be valued at 7*s.*, the cash wages are reported as from 24*s.* to 35*s.* a week,—an average decrease of about 2*s.* a week. In the North-Eastern Counties, where the single men generally get board and lodging valued at 14*s.* a week, the cash wages of single ploughmen are reported as averaging 22*s.* a week, or much the same as last year. In Inverness, Sutherland, Caithness, Orkney and Shetland single men receiving board and lodging are reported as having cash wages from 14*s.* to 20*s.* a week. In the last twelve months there has apparently been a decrease in the average earnings of unmarried ploughmen of about 1*s.* to 2*s.* a week. Their total earnings for all Scotland may be taken as now averaging 34*s.* a week (cash 24*s.*, allowances 10*s.*), compared with 39*s.* for the married ploughmen.

From several districts come reports that farmers are laying down more land to grass and reducing the number of horses they keep and the staff they employ. On the other hand a considerable number of young farm-workers have emigrated to Canada and elsewhere, and complaints are made that, especially in the North-Eastern Counties, the sleeping accommodation and the food provided for the unmarried men on many farms are very inferior. It is to be hoped that Parliament will soon extend the building subsidy to the improvement of existing cottages and bothies as well as to the construction of new ones, and that this may make it possible to provide more cottages large enough to enable the married farm-worker to keep his sons longer at home instead of sending them away to a dull bothy or "chaamur," where the surroundings and the food are often greatly inferior to those they would have if they resided with their parents, as many young ploughmen do in the South-Eastern Counties.

Agreements.—Agreements regarding hours of work and wages have been made, either recently or in former years, between local branches of the National Farmers' Union and the Farm Servants' Union, which have had a considerable effect on the individual bargains made between farmers and workers, but they have not been universally adopted in full, even by the members of the Unions themselves. They are reported as still more or less in force in Berwick, Roxburgh, Selkirk, the three Lothians, Peebles, North Ayr and Argyll, but apparently have not been carried out elsewhere. The arrangement reported in the April issue of this JOURNAL for conducting the hiring fairs in covered buildings with the help of registers of requirements drawn up by the branches of the two local Unions, has been extended to Glasgow, Ayr, Dalkeith, Haddington, Earlston and Hawick, and has proved on the whole successful. It promises to be a great improvement on the old haphazard way of conducting bargains in the open street, in all sorts of weather, perhaps in the middle of a noisy crowd, or in a public-house, and must conduce to the greater comfort of all concerned, and especially of the women.

Women Workers.—In the South-Eastern Counties (Roxburgh,

Berwick, East Lothian and Midlothian), it is common to employ women to work in the fields, engaging them for a year from Whitsunday at a cash wage fixed at so much a week, plus a harvest fee of from £1 to £2, and sometimes a small allowance of potatoes. These additions may be reckoned as worth about 1*s*. a week for all the year round. Their average earnings were about 13*s*. a week in 1914, and are now about 24*s*. (cash 23*s*., allowances 1*s*.), or much the same as last year. In the rest of the country women working on farms, on other than temporary engagements, are generally employed as dairymaids or kitchenmaids, and are boarded and lodged in the farm-house. A common cash wage for a dairymaid is £20 or £22 for the half-year, but some experienced women get up to £25. An experienced kitchenmaid gets about £18 or £21 in the half-year. Casual women out-workers are generally paid at the rate of from 3*s*. to 4*s*. a day, averaging about 3*s*. 6*d*, and sometimes rising to 5*s*. a day during harvest and potato-lifting.

Working Hours on Farms.—As regards working hours no important change has been made in the last twelve months, and the arrangements in force are still much as they were described in the JOURNAL for last October.

Scottish Agricultural Research Conference.

THE fourth annual conference of Scottish Agricultural Research Workers was held at Aberdeen on 6th and 7th July, and was attended by nearly a hundred persons interested or engaged in agricultural research or education in Scotland.

The first session was devoted to a series of papers on "The Role of Iodine in the Nutrition of Animals." Dr. J. B. Orr, director of the Rowett Institute, giving an outline of the history of research in iodine metabolism, stated that until recently it had been chiefly associated with goitre. It had been shown that endemic goitre could to a large extent be prevented and cured by the administration of iodine, and in Switzerland and other countries iodine was being systematically fed to the people with excellent results. In the Middle West of America the feeding of a small amount of iodine to young pigs had prevented a loss estimated at £1,000,000 per annum, and it had also been found that the use of mineral salts containing iodine had prevented goitre in sheep. These discoveries had been of very great economic value to agriculture in America. On the medical side it had been found that the feeding of small amounts of iodine to school children in certain States of America had resulted in freedom from goitre and, in addition, more rapid growth and increased intelligence. These results gave research in iodine a strong practical interest. At the Rowett Institute they had conducted experiments to discover whether the addition of iodine to the normal ration of pigs resulted in increased growth; to investigate the difference in the amounts of iodine in pastures from different areas: and to discover the amount of iodine in milk, and whether that amount could be

altered by feeding iodine to the cows. In some cases, with special diets, the addition of iodine had striking effects; in others it had no effect. The general results seemed to indicate that in many districts at least the iodine intake of animals with their ordinary diet was sufficient, but that in other areas it was insufficient. Interesting results in regard to the use of iodine in the prevention of joint-ill in foals were also discussed. Further contributions were made by Dr. Henderson on the beneficial effects of iodine on human beings and the official means taken in various countries to secure a sufficient intake of iodine; by Dr. Leitch on the varying amounts of iodine found in milk in different districts; by Dr. Macgregor Skene on the influence of iodine in the growth of plants; by Dr. Reid on the stimulating effect of iodine on intestinal movement; by Mr. O'Brien on the value of iodine in preventing navel-ill in foals; and by Mr. W. Brown on the therapeutic aspect of iodine.

Dr. H. E. Magee and Mr. A. Crichton gave details of experiments on the effect of heat on the nutritive properties of milk. An article on the subject will be found at page 377 of this Journal.

Messrs. A. Calder, B.Sc., and A. D. B. Smith, B.Sc., contributed a paper on "The Part Played by In-Breeding in the Formation of the Clydesdale and Shorthorns respectively." This dealt with the different systems of in-breeding practised in the two breeds and showed that, while very little in-breeding had taken place in the foundation period of Clydesdales, in the case of the Shorthorn the most intensive in-breeding took place in the formative stages. Homozygosity had been attained in the case of Shorthorns by in-and-in breeding and in the Clydesdales by resorting to line breeding. Other systems of in-breeding were referred to with the object of showing the systems of mating which gave the best results.

In view of the attention that is now being directed to problems of soil investigation and of the great importance attached to the development of the knowledge of colloids and colloid chemistry, Professor Hendrick's paper on "The Exchangeable Bases of the Soil" was of particular interest. He stated that the clay and the humus were both capable of absorbing and of fixing bases from solutions of neutral salts, and at the same time of giving up to the solution other bases in equivalent amount. That was what was called base exchange. As a rule lime was the principal exchangeable base held by the soil, but by continued treatment with a solution of a salt of one particular base all the other bases could be replaced by that one base, the others entering into solution. A much clearer view as to base supply in the soil and its relation to soil properties and fertility had recently been gained, and it was probable that future knowledge of replaceable bases would greatly modify methods of soil analysis.

In a supplementary paper on "The Bases in the Drainage of Craibstone Soil," Mr. Hugh D. Welsh said that few investigations as to the composition of drainage from agricultural land had been carried out in this country. For agricultural purposes it is important to know what is removed from the soil in the drainage water, and to what extent.

A short account of results obtained by other investigators was given with reference to the bases removed.

It was pointed out that most of the results recorded elsewhere are obtainable from soils which have been filled into the lysimeters. Owing to the thorough breaking up and aeration which the soils undergo their state of consolidation is altered, chemical changes are accelerated, and the manner and rate in which water and air pass through them is greatly changed. It is better therefore that the soil should be in its natural condition as in the Craibstone lysimeters. These were described, and an account was given of their cropping and manurial treatment.

Lime was removed in the drainage to a greater extent than any of the other bases determined. Dung and artificials had little effect on the amount, but the addition of lime raised the concentration in the drainage, especially in the first two years. The greatest concentration occurred when the plots were bare.

Magnesia was found in much smaller amount than calcium. Dung and artificials effected a rise in concentration in the second year only. Lime increased the content in the first two years, when there was a falling away.

Potassium was removed in smallest amount. Dung and artificials had no effect on the concentration, but lime raised it in the first year, after which there was a decrease.

Sodium was leached out in almost the same concentration as lime. Dung and artificials did not show an increase in any year, while lime gave an increase in the first year which raised the average figure considerably.

The loss of nitrogen in the drainage was very small. In the first year of observation the loss was about 43 lbs. per acre per annum, but it is evident that with cropping little nitiate escaped to the drainage even in wet weather, and seldom exceeded 1 lb. per acre per month.

It appears that the danger of washing out of nitrogen and soluble manures is much less than is generally supposed, especially when the soil is covered by crop.

Mr. D. G. O'Brien, Advisory Officer in Plant Pathology at the West of Scotland College, gave a paper on "A Nematode Disease of Potatoes." This disease had been found to be caused by the attacks of the beet eelworm, and was fortunately confined as a rule to gardens, allotments, and districts where potatoes were grown in close rotation in the field. A serious aspect of the disease was that it exposed the plant to secondary infection of all kinds. It was considered that biological methods of control would be more practical in combating the parasites than soil sterilisation or general chemical methods.

Mr. J. A. Symon, one of the Board's inspectors, contributed a paper on an agricultural survey of Kincardineshire carried out in the winter of 1924-5, an account of which appeared in the July number of the JOURNAL.

Heather Burning (Scotland) Act, 1926.

THE Heather Burning (Scotland) Act, 1926, which was introduced to the House of Commons as a private Member's Bill in February last, received the Royal Assent on 4th August. Before describing briefly its provisions it may be of interest to refer to previous legislation and investigations on the subject.

Game (Scotland) Act, 1772.—Except during a period of emergency caused by the Great European War, heather burning in Scotland has until now been regulated by the old Game Act of 1772. Under this Scottish statute the burning of heather was in normal circumstances prohibited during the period from 11th April to 1st November in any year. In the case of "high and wet muirlands," however, a proprietor occupying such land had the right to burn heather thereon between 11th and 25th April. A similar privilege was extended to a tenant, provided (1) he had obtained the written consent of the proprietor, and (2) this authority had been recorded in the Books of the Sheriff Court. These provisions, frankly in the interests of the preservation of game, gave a limited power of discretion to the proprietors of "high and wet muirlands"; grazing tenants occupying such lands were dependent upon the proprietors or their deputies for the manner and the extent to which this power was exercised.

Defence of the Realm Regulation 2M (10) (1917-1921).—During the war, when the importance of food production was paramount and the complete utilisation of hill grazings formed part of the nation's agricultural policy, it was enacted by Regulation 2M (10) of the Defence of the Realm Regulations that "the occupier of any land in Scotland shall be entitled after due notice in writing to the owner of such land and to the owner of adjoining woodlands, and with due care to prevent damage, to make muirburn at any time between 1st October and 30th April, when the same would otherwise be unlawful." This regulation had effect from 29th March 1917 until 31st August 1921; during that period, therefore, the grazing tenant had, subject to the terms of the Regulation, statutory authority to burn heather on land of any class in his occupancy, not only during the period hitherto prescribed by the Act of 1772, but also in the month of October and in the last twenty days of April.

Game and Heather Burning (Scotland) Committee (1919-1921).—The question of the adoption as part of the permanent Code of the provisions of Regulation 2M (10), and various other emergency measures having relation to game, occasioned much controversy at the end of the war. For the purpose of clarifying the several problems then under discussion, the Secretary for Scotland of that time appointed in November 1919 the "Game and Heather Burning (Scotland) Committee" to consider and report, *inter alia*, whether the provisions contained in Regulation 2M (10) of the Regulations for the Defence of the Realm "should be permanently enacted with or without modifications, and if with modifications, with what modifications?" This Committee made exhaustive inquiry in the matter of heather burning and heard a considerable volume of evidence on the subject. In their report presented in July 1921, they discussed the reasons that had contributed to the

general failure in Scotland either to appreciate the advantages of burning heather in a systematic rotation or to adopt such a practice. Through this continued neglect the output of mutton and wool from hill grazings was much lower than it might be. The Committee suggested various reasons for the condition referred to, e.g.:—

(1) The interest, or supposed interest, of the shooting tenant who may be ignorant of the advantages of systematic burning.

(2) The fact that especially on some of the smaller estates undue authority is relegated to gamekeepers.

(3) The difficulty of burning a regular area of heath every year owing to the variability of the season.

They concluded that, while the provisions of the Act of 1772 did not safeguard the reasonable interests of the grazing tenant, the indefinite continuance of Regulation 2M (10), under which tenants were granted sole control of the burning on land in their occupation, could not in justice be supported. The Committee recommended that the Agricultural Committees, acting on instructions given by the Board of Agriculture for Scotland, should ascertain the arrangements in force on each estate in their respective areas. Where these appeared to be unsatisfactory, the Agricultural Committee should endeavour to obtain the adoption by voluntary agreement of a scheme that would secure the interests of all concerned. Failing such agreement, recourse should be had to compulsory power vested in the Board. The Committee considered that the onus of burning should rest with the proprietor, who might, if he desired, transfer the responsibility to the grazing tenant. On the question of the legal period for burning, the Committee proposed that the normal season should be from 1st October to 15th April (instead of from 1st November to 10th April, as in the Act of 1772), with extension to 25th April if this were warranted owing to the condition or the situation of the moor. This extension should be recorded with the Agricultural Committee, instead of being recorded in the Sheriff Court Books, as under the Act of 1772.

It may be noted that the local Agricultural Committees in Scotland referred to above were disbanded at the end of 1922.

Heather Burning (Scotland) Act, 1926.—The new Act, which is now in operation, provides that the statutory period for heather burning in Scotland shall be from 1st October to 15th April of the following year instead of, as heretofore, 1st November to 11th April. Should, however, the proprietor of any class of land, or the tenant with the proprietor's written authority, so desire, he may burn heather between 16th and 30th April of any year. Further, if the lands in question are a deer forest situated at more than 1500 feet above sea level, the limit of this extension of time is 15th May, subject always, in the case of a tenant, to his obtaining the proprietor's written authority.

Any tenant of land who is of opinion that he is unduly restricted, either by the terms of his lease or otherwise, in the matter of heather burning, is entitled to apply to the Board of Agriculture for Scotland for an Order regulating "muirburn" on his land. If, after certain statutory procedure, the Board are satisfied of the

merits of the application, they may make an Order prescribing the conditions under which heather burning may be carried out in any year during the currency of the lease. Such an Order shall not, however, authorise heather burning on any day outside the period between 1st October and 15th April of the following year; the extension of the latter date to 30th April, or to 15th May in the case of high-lying deer forests, will depend upon the proprietor's consent being obtained as indicated in the preceding paragraph, or upon the operation of a further provision of the Act which is referred to below.

If the tenant of any lands who, either in terms of his lease or by virtue of an Order made by the Board of Agriculture for Scotland for the regulation of muirburn on these lands, is entitled to burn heather after 16th April desires to do so, it is necessary for him to apply to the proprietor or his agent for written authority. If within seven days of the application the proprietor has intimated his refusal or has failed to reply thereto, it is open to the tenant, after giving written notice to the proprietor, to make an application to the Board of Agriculture for Scotland. If, on consideration, the Board are satisfied of the expediency of the tenant's proposals, they may make an Order authorising the tenant, subject to any necessary conditions, to burn heather during the whole or part of the period from 16th to 30th April, or from 16th April to 15th May in the case of high-lying deer forests, of the year to which the Order relates.

The provisions of the old statute for the recording of special authorities in the Books of the Sheriff Court are repealed.

The term "tenant," in addition to its ordinary meaning, is defined as including the Committee appointed under the Small Landholders (Scotland) Acts for the management of any Common Grazing to which these Acts apply.

Reviews.

Rural Scotland during the War, by various Authors. (Oxford University Press, 12*s.* 6*d.* *net*). This is a new volume of the British Series of the "Economic and Social History of the World War," promoted by the Carnegie Endowment for International Peace. The British series, which is much further advanced than that of any other country, now runs to sixteen volumes or parts of volumes, and about a dozen more are in preparation. This is the second volume devoted exclusively to Scotland, the other being "The Industries of the Clyde Valley during the War," and it deals, besides agriculture and land settlement, with fisheries and with the jute industry, which do not directly concern the readers of this Journal. Professor W. R. Scott, who is a member of the Editorial Board for Great Britain, has edited the volume, with an introduction, and has also contributed an account of Scottish land settlement. "Scottish Agriculture, with special reference to Food Production," is the work of Mr. H. M. Conacher, while Mr. J. F. Duncan writes on the "Scottish Agricultural Labourer."

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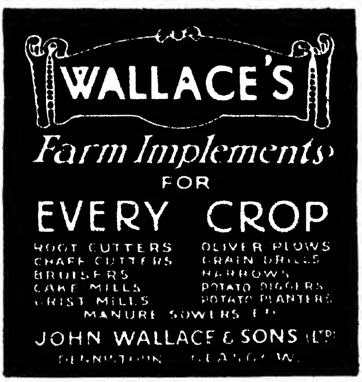

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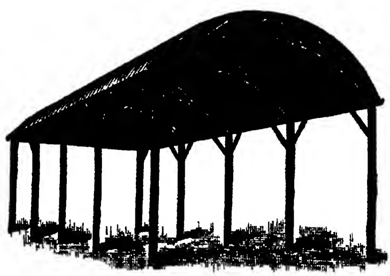

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CLYDESDALE IRON WORKS,
POSSILPARK, GLASGOW.

1918, and the interval is long enough for the story of the struggles of the war to come with a certain freshness to the reader's mind. Mr. Conacher's subject was briefly dealt with by Sir Thomas Middleton in a chapter in his volume in the same series on "Food Production in War," but the present writer naturally goes into much greater detail. Beginning with a description of the characteristics of Scottish agriculture as determined by geology and climate, he shows that at the outbreak of war the Scottish farmer had "less to recover" than the English, owing to the comparative importance in Scotland of beef, mutton and wool, the home market for which had suffered less than that for wheat. Further, the Scottish system of long rotation, in contrast with the sharp division in England between arable land on short rotation and permanent grass, made it easier for the Scottish farmer to turn over for a time to the increased production of cereals and potatoes. Dealing in detail with various aspects of farming, Mr. Conacher expresses the views that "altogether the sheep farmer did well out of the war;" that "as finally adjusted, the system of controlled prices does not seem to have worked unfairly for the Scottish dairy farmer;" and that "the movement for increased production (of wheat, oats and potatoes) in Scotland was directed with judgment and intelligence, and the results were obtained without disproportionate loss to the taxpayer either in liabilities for compensation or in improvising the necessary machinery on an extravagant scale." The great increase in the production of cereals and potatoes in 1917 and 1918 was carried out without any marked decrease in the numbers of live stock, and it is also notable that the enormous acreage of oats in 1918 gave an average yield per acre $2\frac{1}{2}$ bushels above the average of the preceding ten years.

Before the end of the war practically everything the farmer produced or used was subject to maximum prices controlled by one department or another, and many of his requisites were rationed. The minimum prices fixed for wheat and oats by the Corn Production Act of 1917 did not operate in practice, but the guaranteed price for potatoes of the 1918 crop led to some difficulty owing to the unexpectedly large surplus that was left at the end of the season.

Mr. Conacher points out that as affecting agriculture the late war is not to be compared with the revolutionary and Napoleonic wars; but that a century ago other forces were at work besides the war to change the conditions of agriculture. It is doubtful whether the war has made any great difference to the future of Scottish agriculture on its broader lines. Among the temporary war measures, however, were the increased powers given to tenant farmers to destroy game and deer damaging their crops, and to burn heather. The withdrawal of these powers has given rise to much discussion, and the *status quo* may not ultimately remain.[1] A probably permanent result of the war, and one of some importance, is the working of allotments by townsmen, which scarcely existed in Scotland before the war.

[1] The Heather Burning (Scotland) Act, which received Royal Assent on 4th August last, is dealt with elsewhere in this issue of the JOURNAL.

No one more competent than Mr. J. F. Duncan could have been chosen to write about the Scottish farm servant. His first chapter gives a concise account of the pre-war conditions of service on Scottish farms—housing, hours, wages and methods of payment. "The Scottish farm worker," he says, "is still a craftsman with a real pride in his craft." As compared with those of England, the men on Scottish farms are more highly specialised, and more women are regularly employed. Further, there had been for some years before the war a steady stream of emigration, largely to Canada, and mainly from the eastern and north-eastern districts, where unmarried men predominate. Hence it might seem that there was less possibility of recruitment for the army in Scotland than in England. But by July 1918 the figure had risen to 36·5 per cent., which means probably that more than half the men in the prime of life had been taken for the army. About half the total deficiency was made up by lads under military age and by substitute labour, less efficient than the men that had gone. Seasonal help was also given by soldiers, many of them quite unused to farm work. In these circumstances, great credit is due to the farm workers for the results that were obtained in 1918.

Mr. Duncan deals at some length with the question of wages, and with the Wages Committees set up under the Corn Production Act. "Taking the country as a whole," he says, "it is the fact that the fixing of minimum rates did not serve any useful purpose for the workmen in agriculture in Scotland." In the matter of hours and social conditions he is able to point to more satisfactory results. The movement for shorter hours which had begun before the war was resumed when the strain was over, and now "it is generally true to say that farm workers are working at least ten hours a week less on the average than was the case at the outbreak of war." Apart from such changes as this the war indirectly increased the farm workers' sense of their own value to the community. "Their industry became one of the most essential in the nation. . . . From an inarticulate class they progressed rapidly until they had a voice in communal affairs."

The most hopeful social change is the founding of the Scottish Women's Rural Institutes, which are rapidly covering rural Scotland. The National Farmers' Union of Scotland and the Scottish Farm Servants' Union have branches in every county, and "altogether the war years have brought to rural Scotland a welcome increase in associated effort, which cannot be without effect in building up the much-needed community and social interest."

Professor Scott had a difficult task in compressing into forty pages an account of Scottish Land Settlement. His article is in fact, so far as we are aware, the first comprehensive review of the subject that has appeared. The successive reports of the Board of Agriculture for Scotland tell the story of its work from year to year, with incidental remarks on special points that may emerge. The eloquence of politicians has thrown on the subject more heat than light. Professor Scott has the advantage of being an unofficial and non-political person, with a wide knowledge of the economic history of Scotland and a capacity for disentangling the essentials from a thicket of controversy.

A brief summary of the events that produced unrest in the Highlands and Islands leads on to the appointment of the Crofters Commission (to which Professor Scott makes only a passing reference) and the Congested Districts Board. The Highlander "refused to become an 'economic man,' and remained essentially human, if sometimes a little perverse," and in the last quarter of the 19th century the assumption generally made by responsible persons that the land question was a purely economic one began to give way. It was recognised that questions of a social nature and of general policy were also involved. Hence the prominence of the Scottish Land question in the policy of the Liberal Government of 1905, which after a long struggle got the Small Landholders Act passed in 1911. "It is possible, even probable," says Professor Scott, "that this Act represents the greatest common measure of agreement amongst a variety of opposed opinions that was obtainable at the time. But it was the tension of contending forces and represented a highly unstable equilibrium." Thus the new Board of Agriculture was faced with considerable difficulty in endeavouring to carry out the duties laid upon it. Professor Scott rightly points out that the problem was exceedingly complicated owing to the diverse nature of local conditions. Further the expectations both of applicants for holdings and of their Parliamentary supporters were disappointed by the delays, largely unavoidable, that attended the Board's work throughout the first two years. Then for four years land settlement work was almost at a standstill.

With regard to the post-war policy of land settlement "much criticism," says Professor Scott, "is ill directed in so far as it views a past situation in the light of fuller later knowledge," and we may remark that in his comments he perhaps hardly gives enough weight to this consideration. His chief criticisms are that the work of preparation for dealing with demobilised men should have been further advanced when the Armistice came; that steps should have been taken to have a certain number of holdings ready as soon as possible after demobilisation (on which it may be pointed out that such procedure was of doubtful possibility under the Board's existing powers); and that the reduction, in October 1919, of the annuity for repayment of building loans, with interest and insurance, to £2 per £100, with a corresponding increase in the length of the period of repayment, was an unwise step.[1]

It must not be thought, however, that Professor Scott undervalues the work that has been accomplished, or ignores the success of small holders fortunate enough to have been settled before the inflation of values took effect. He points out, too, that the post-war situation was immensely complicated by the danger of grave social disorder in certain districts if there had been prolonged delay after demobilisation, and in such conditions loss was inevitable. For the delay and disappointment that did occur he does not blame the Board of Agriculture exclusively. "Dealings had to be carried on with law agents in Edinburgh, whose business and disposition it is to exhaust all the resources of the law." Again,

[1] The revaluation mentioned in the footnote to p. 253 of Professor Scott's article has now been completed.

with regard to Highland applicants, "If we mean to pay a man £1 in the future, it is not safe to promise him more than 5*s*. The latter sum will grow in his mind to such an extent that when he receives his £1 he will be disappointed, but not bitterly so."

The position now is that the claims of ex-service men are within sight of being provided for, subject to a strict observance of the Government's instructions as to economy. There remains the wider question of the civilian demand. "When the time comes," says Professor Scott, "it will be necessary to reconsider the whole position. Something will have been accomplished towards meeting the social ideals which lay at the root of the movement, but not enough. . . It will be a question of what the country can afford to spend upon a movement which, in Scotland, has many social arguments in its favour."

Preliminary Report of an Investigation into the Artificial Drying of Crops in the Stack. Bulletin No. 2, Institute of Agricultural Engineering, University of Oxford. (Clarendon Press, 2*s*. 6*d*.)—In a damp, uncertain climate such as that of Britain it would be a great advantage to the farmer if he could stack his grass and clover green and dry it into hay in the stack, and if he could safely stack his wet sheaves on a moist autumn morning direct from the binder and then, by driving the moisture out of the stack, get his grain and straw into good condition. The advantage would be still greater if he could do these things more cheaply than he can make hay or save grain in the ordinary old-fashioned way in the field. The problem of artificially drying fodder and grain crops is an attractive one, and many attempts have in recent years been made to solve it. The latest of these attempts has been made by the recently founded Institute of Agricultural Engineering at Oxford, and Bulletin No. 2 gives an account of the investigations and experiments which have been carried out under the auspices of the Institute.

The Bulletin is divided into two parts and Appendices. Part I is called "Field Work," and gives an account of certain of the practical trials of crop drying carried out in the years 1923, 1924 and 1925, while Part II deals with Laboratory work and Theoretical Considerations. It is to Part I that one turns with most interest.

The trials in 1923 were mainly with cold air and were merely preliminary. In 1924 the trials were with air heated in the apparatus which is the special feature of the Oxford system. Three such sets of experiments are described, and it is concluded from results that the system is practical and economical, and consequently manufacturers were allowed to make machines of the approved design and place them on the market for the season 1925. It is stated that in 1925 there were 13 demonstrations in various counties and five at Agricultural Shows. Some account is given of five of these only, including the experiments carried out at Craibstone, of which an account has already appeared in this Journal.[1] Few details are given of any of these five demonstrations and in no case is the cost of drying the hay or corn stated,

[1] "Experiments on Making Hay with Heated Air," April 1926, pp. 136-46.

though it is claimed or inferred that all were successful, except that at Craibstone, where the "very disappointing" results are ascribed to the machines being "mechanically defective." Even in the case of this experiment it is stated that "the hay produced was of fine quality," but it is not mentioned that only a small part of the grass used was turned into hay at all, and that at an excessive cost. The general conclusion drawn from the demonstrations and experiments of 1925 appears to be very optimistic in view of some of the results actually obtained.

The longest section of the Bulletin is Part II, much of which is of comparatively little importance. While this part contains much elementary theoretical matter, which might have been cut down without reducing the value of the Bulletin, more space might well have been given to Part I. Precise and accurate details as to such ordinary matters as the moisture in the crops at the start and at the conclusion of drying, the fuel consumed by the motor and by the heater per ton of crop dried, the cost of fuel on the farm per ton of crop dried, &c., would have been useful, and it would have inspired more confidence in the general methods by which these experiments are carried on and in their results had such information been given.

One finishes the perusal of this bulletin with the impression that a great deal still remains to be done before a reliable and economical method of drying crops in the stack, fit to be used by the ordinary farmer, is produced.

Estate Accounts, by C. S. Orwin and H. W. Kersey. (Cambridge University Press, 3*s.* 6*d.* net.)—This little book will appeal, by its title, to the small but diminishing circle of people who are interested in Estate Management; and that appeal will be enhanced when the reader finds not only that the authors possess a practical knowledge of estate accounts, but also that they have written what they have to say in a direct and lucid style without padding or circumlocution.

The book is obviously based on the conditions and practice prevailing in England, and probably the authors would not claim that what they have to say applies equally to the practice of estate accounts in Scotland. The word "obviously" has been used because the two following extracts near the beginning of the book cannot truly be applied to Scotland:—

(1) "Although the days are gone (though not very long since) when it was not uncommon to find that the accounts of very considerable estates were comprised in a cash book, it is still doubtful whether the full value of book-keeping as an aid to management is sufficiently realised."

(2) "It will be within the memory of some that when provision was first made, in the year 1910, to refund to landowners income tax in respect of income laid out on maintenance of property in excess of the statutory allowances, a very small proportion of the amount budgeted for by the Chancellor of the Exchequer was claimed during the following year or two, because comparatively few estate offices kept books in a form

which would provide the information needed to substantiate a claim."

All this may be perfectly true of England, but in the absence of direct proof it would be surprising to know that Scotland had not claimed the repayment of a tax to which she was legally entitled, and it would be even more surprising to know that it was due to the absence of proper accounting by the estate factors of Scotland, who are noted for the thorough way in which they keep their accounts. It would be interesting to trace to its source this characteristic of estate management in Scotland, and to find out whether it was due to the inherent frugality of the race or to the association of so many landed estates with legal firms, who, in co-operation with the landlords and factors, have raised the keeping of estate accounts to a very high standard.

The space available for this review does not permit of a detailed discussion of the contents of the book, but there is room for a few observations. Although one may not agree with some of the details of the system of book-keeping or the forms given here, every agent and factor will heartily agree with the two general principles which the authors have emphasised in their introductory remarks. The first is that the system of book-keeping should be as simple as possible, "so as to entail the minimum of clerical work compatible with the maximum of information on the progress of management"; and the second is that no stereotyped form of accounts can be devised which can be the most suitable for every estate, or, as it is summed up by the authors, "No form is best in all circumstances and for all time."

In the chapter on the "Description of the Account Books required" one misses any reference to a Rent Ledger in which the state of every tenant's rent account can be seen at a glance, and which in Scotland is regarded as an indispensable part of the equipment of an estate office.

The book should be stimulating and helpful to the young student, and factors will read it with interest and pleasure; nevertheless, so far as Scotland is concerned, it is not likely to cause many changes in the existing system of keeping estate accounts.

General Assembly of the International Institute of Agriculture.

THE Eighth General Assembly of the International Institute of Agriculture was held in Rome from 19th to 26th April 1926, and was attended by representatives of 62 different countries. The British Delegation included representatives of the Ministry of Agriculture and Fisheries, the Board of Agriculture for Scotland, and the Ministry of Agriculture, Northern Ireland, and also, for the first time, a representative of farmers' associations in Great Britain.

The financial position of the Institute gave rise to much anxious discussion, and the scheme finally adopted is a compromise between the Institute's needs and the ability or willingness of the various Governments to make adequate contributions. The estimated income for the years 1927 and 1928, reckoned in gold, is

about equal to the income received before the war, so that no allowance is made for the decrease in the purchasing power of gold. The salaries of the Institute's officials are inadequate, and, while further provision is being made to meet the increased cost of living, the whole question of salaries is to be considered at the next Assembly. The British Government's contribution under the new scheme will actually be less than it has paid under the provisional scheme recently in force (see Vol. V. of this Journal, October 1922, page 428), and it has been suggested that the balance should continue to be paid for such purposes as that of the Bureau of Colonial and Tropical Agriculture mentioned below.

The General Assembly of 1924 decided that the Institute should endeavour to establish direct relations with agricultural associations throughout the world. Formerly its direct communications were confined to Governments, and all the delegates to the successive Assemblies were officially nominated. It was, however, felt that contact with unofficial opinion would be of advantage, and a scheme has been formulated to attain this. As has been mentioned, the British Delegation on this occasion included an unofficial member, and further steps are being taken to bring (so far as Scotland is concerned) the Highland and Agricultural Society, the Chamber of Agriculture and the National Farmers' Union into direct relation with the Institute.

A new project of importance is the establishment of a Bureau of Colonial and Tropical Agriculture in the Institute, to give greater attention to tropical products than has hitherto been possible. It is hoped that the Governments concerned, among which our own is included, will be disposed to make special contributions for this purpose.

On the statistical side the chief subject of discussion was the World Census of Agriculture proposed to be taken in 1930. Before the Assembly met there was a conference of statisticians who revised a draft scheme prepared for their consideration, and this scheme as revised was adopted by the Assembly. The International Education Board of the United States has made a substantial grant towards the expense of this great enterprise, and an American expert is engaged in the preliminary work.

The Assembly of 1924 passed certain resolutions regarding the organisation of the Institute's work. Some of the Delegations expressed the view that these resolutions had received insufficient attention during the intervening years. The question was complicated by the existing political situation in Italy, and public discussion of the points involved was felt to be inexpedient. The United States Delegation submitted a "Statement of Principles" which, with modifications, was adopted by the Assembly, and Sir Daniel Hall, head of the British Delegation, said that they expected the reorganisation scheme to be carried before the next Assembly. If they were satisfied as to the future working of the Institute, they were prepared to recommend the British Government, if necessary, substantially to increase its contribution.

Publications.

Agricultural Statistics of Scotland, 1925.—All three Parts of the Agricultural Statistics of Scotland for 1925 have now been issued by H.M. Stationery Office. Part I contains the returns of acreage and live stock for each county and county district, and also gives particulars regarding agricultural holdings and agricultural workers; Part II deals with the produce of the principal crops, details being given for counties alone; Part III records the prices of agricultural produce and requisites and the supplies of live stock at certain markets. The prices of the three Parts, which may be obtained either directly or through any bookseller from H.M. Stationery Office, 120 George St., Edinburgh, are 3*s*., 1*s*. 3*d*., and 2*s*. respectively, or 6*s*. 3*d*. in all. These prices show a substantial reduction as compared with those charged for the statistics for 1924, which amounted in all to 10*s*.

Guide to Current Official Statistics, Volume IV.—The new issue of the GUIDE deals with statistical publications issued during the year 1925, and also includes as usual references to those issued in the earlier part of the present year. We are glad to note that this volume has been issued at an earlier date than any of its predecessors. Further progress in this direction will greatly increase the usefulness of the GUIDE. We need not repeat what we have said on earlier occasions (see the issues of this Journal for January 1924, January 1925 and January 1926) regarding the scope and plan of the GUIDE, which is now widely recognised as an indispensable book of reference. Copies may be obtained from H.M. Stationery Office, 120 George St., Edinburgh, either directly or through any bookseller, price 1*s*. net, or by post 1*s*. 3½*d*.

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Agricultural Workers' Scholarships

THE scheme for the provision of scholarships and maintenance allowances for the sons and daughters of agricultural workmen and others in Scotland was instituted in 1922 in accordance with the provision of section 3 of the Corn Production Acts (Repeal) Act, 1921, by which a sum of £150,000 was paid into the Agriculture (Scotland) Fund "for the purpose of providing a special fund for promoting agricultural development, including the establishment of scholarships and maintenance grants for the sons and daughters of agricultural workmen and others." From the money thus provided a sum of £15,000 was set apart for the scholarship scheme; and it was decided that this sum should be spent over a period of five years, during which the scheme would be regarded as experimental.

Scholarships were awarded under four classes as follows:—

Class I. Short Course Allowances, not exceeding 35*s*. per week for the period of the course, which enabled the holders to attend short courses of from four to ten weeks' duration in agriculture, horticulture, dairying, poultry-keeping, &c.

Class II. Certificate Course Scholarships, each not exceeding £30 in value, which enabled the holders to attend courses of instruction in agriculture, horticulture, dairying, poultry-keeping, &c. These courses, as a rule, required attendance at classes during one session of about twenty weeks.

Class III. Diploma Course Scholarships, each not exceeding £120 in value, or £40 per session, which enabled the holders to attend the courses of instruction for diplomas awarded by Agricultural Colleges in Scotland. These courses, as a rule, required attendance at classes during three sessions of about twenty weeks each.

Class IV. Degree Course Scholarships, each not exceeding £360 in value or £120 in any one year, tenable while students attended courses of instruction for the degree of B.Sc. (Agriculture) of a Scottish University during three academic years or thereby, or for the qualification of M.R.C.V.S. at the Edinburgh or Glasgow Veterinary Colleges, which extended over four sessions.

In addition to these allowances, class fees were paid in respect of all scholarships awarded; and in certain cases allowances were made to cover necessary travelling expenses.

Benefits under the scheme were confined to—

(*a*) The sons and daughters of agricultural workmen;

(*b*) The sons and daughters of other rural workers, including smallholders, whose financial circumstances were comparable to those of agricultural workmen;

(*c*) Persons who were themselves *bona fide* workers in agriculture, or its allied pursuits, whose financial circumstances were comparable to those of agricultural workmen.

All applications were submitted through the Education Authorities, who had the opportunity of making any recommendation or of offering observations on them. They were then considered by a committee consisting of representatives of the Board of Agriculture for Scotland, the Scottish Education Department and the Scottish Farm Servants' Union, who recommended to the Board the most suitable candidates for awards. Particulars of the number of applications received and the number of scholarships awarded in each year are given in the following table:—

	Class I.		Class II.		Class III.		Class IV.		Total.	
	Applications.	Awards.	Applications.	Awards.	Applications.	Awards.	Applications.	Awards.	Applications.	Awards.
1922	28	9	20	6	30	3	21	3	99	21
1923	36	18	33	6	44	3	23	4	136	31
1924	34	3	39	9	34	5	22	8	129	25
1925	16	8	28	7	38	8	33	6	115	29
1926	21	6	26	9	25	9	39	6	111	30
	135	44	146	37	171	28	138	27	590	136

Periodic reports submitted by the authorities of the various institutions on the work and progress of the scholarship holders have shown that, with very few exceptions, the beneficiaries have made good use of the opportunity for further study thus granted to them, and not a few have taken distinguished places in their classes.

Agricultural Conditions.

THE weather during June was changeable but generally favourable for growth, and crops made satisfactory progress; occasional cold spells and night frosts were experienced on exposed ground. During the first two weeks of July dry sunny conditions prevailed generally, the mean temperature being well above the normal. The last fortnight of the month was, however, unsettled, and thunderstorms, accompanied by heavy rains, occurred in many districts, considerable damage being caused locally by flooding. The dry bright weather in the early part of the month facilitated the securing of hay and hastened the ripening of cereals, while potatoes and roots benefited very much by the rain that fell later. Broken weather continued for the first three weeks of August, with the result that harvesting operations were delayed and many of the finest fields of grain were laid and twisted; heavy rain was general during this period, but north of the Forth and Clyde bright intervals were frequent when warm drying winds favoured the ripening of cereal crops. A spell of uninterrupted fine weather occurred during the last eight or nine days of the month and very satisfactory progress was made with harvesting.

Wheat made satisfactory growth during the summer months, and at the end of August reports showed that the crop generally was healthy, while the ears were well-filled and the grain had ripened satisfactorily. In most districts harvesting commenced during the last week of August, and in South-West Forfar and South-East Perth the work was nearly completed at the end of the month. In North-East Fife the crop stood up well to the heavy showers of rain that fell during July and August, but several cases of "rust" have been reported, especially on farms along the coast; reports from South-West Forfar and the Lothians, however, state that in many fields the crop has been laid by storms. Fully average yields are expected in all districts where the crop is grown, while in Fife it is estimated that the yield will be about 5 per cent. and in South-East Perth about 10 per cent. above normal.

The barley crop was unusually healthy this year and developed well, with a fine head and a good length of straw; wind and rain storms, however, soon caused the crop to become more or less badly lodged and twisted. Cutting, which began during the second week of August, was general by the end of the month, and in most districts was then well forward, notwithstanding the delays caused by broken weather. An average yield, or slightly over, is anticipated in all districts where the crop is extensively grown except South-West Forfar and Berwick, where the effects of lodging proved to be particularly serious. Bere is stated to be a good crop. Harvesting was in progress at the end of August in practically all districts where the crop is grown; an average yield is generally expected.

Oats ripened rapidly during August and developed into a bulky crop as regards both grain and straw. Reports received at the end of July showed that at that date the crop had not been so badly laid generally as in the case of barley, but during the month of August, owing probably to the softness of the straw and the heavy heads of grain, oats were less able to withstand the strong

winds that occurred, and complaints of lodging have been received from most districts. Harvest was expected to be general during the first week of September, much of the grain having been cut before the end of August, while on some farms a proportion of the crop had been stacked. Yields 15 per cent. above the average are anticipated in South-East Perth and Stirling, while in many other districts the estimates are from 5 to 10 per cent. above the average, and in no instance is it thought that the yield will be below the normal.

Beans now have a fine healthy appearance, and cutting has begun in North-West Lanark, North Ayr and Renfrew. Average yields or over are looked for in most of the districts where the crop is grown, and only in Berwick and Dumfries is the yield expected to be below the normal.

Potatoes made good progress during June and July, but in August blight became prevalent to a greater or less extent in almost every part of Scotland, particularly in Perthshire and the south-eastern districts. In a few northern and south-western areas, however, the crop is reported to be quite strong and healthy, while in many districts elsewhere the disease has not gone so far as seriously to affect the yield. From South-East Perth it is reported that many farmers have lifted part of their crop on account of disease. Reports show, however, that in eighteen districts yields varying from 5 to 10 per cent. above the average are expected, and it would appear probable that, after allowing for the indifferent condition of the crop where it is badly affected by blight, the yield for the country as a whole will show little variation from the normal.

Reports on turnips and swedes are varied. In June resowing was necessary in several districts, mainly owing to damage done by the turnip fly, while at the end of July "finger and toe" was reported from every county along the east coast except Aberdeen and Caithness. The crop made fair progress generally, however, and at the end of August in south-western districts it was said to have a very good appearance, while in the east the roots, where sound, were reported to show vigorous growth; in some instances "finger and toe" was less conspicuous than it had been in July. In South-East Lanark a yield 15 per cent. above the average is anticipated, and in twenty-one other districts the crop is expected to exceed the normal by from 5 to 10 per cent., but in eight districts, including the western islands and parts of Aberdeen, Perth and Forfar, it is estimated that the yield will fall below the average. Mangolds are generally described as a healthy crop; an average yield or over is expected in all districts where they are grown. The sugar beet crop is reported generally to have a healthy and satisfactory appearance. The roots are most strong and vigorous in South-West Forfar, Fife, Kinross, Peebles, the Lothians, Stirling and North Ayr. "Bolting" is common in parts of Aberdeen, Perth, Fife and Berwick.

The yield of small fruit proved to be poor in most districts, the exceptions being Moray, South-West Banff and Central Argyll, where the crops were of average bulk; in Central Perth strawberries yielded well but raspberries were a light crop. Apples, pears and

plums are small crops in South-East Perth, but the quality is expected to be good by reason of the favourable weather that occurred during the ripening period. In Dumfries apples are a good crop, but pears are only fair and plums and damsons unsatisfactory, while in North-East Fife and Lanark fruit of all kinds has yielded disappointingly.

In most parts of the country pasture was plentiful during June, July and August, white clover being abundant in some areas. Grazing cattle have thriven, while dairy cows are reported to be in good average condition and milking well. Sheep on arable farms are generally stated to be doing fairly well, and in some districts they are said to be in very good condition. In North-East Aberdeen, Berwick and North Ayr, however, lambs are scarcely so well forward as is usual at this season of the year, and in Roxburgh, Selkirk and Dumfries many sheep are reported to be suffering from lameness on account of the wet state of the ground. The reports on hill sheep are satisfactory in every way except that in one or two districts lambs have not developed quite so well as usual.

Bees generally are in a flourishing condition and reports indicate that most hives are unusually free from disease. Clover has been abundant this year, and in many areas the production of clover and flower honey has been larger than usual.

The supply of regular workers has been adequate for requirements, but casual labour for turnip-hoeing, hay-making and harvesting has been short in some districts; in industrial areas where unemployed miners are reported to have offered their services to farmers the supply is now quite sufficient for present requirements, but in the districts of North-East Banff, East Aberdeen, South-West Forfar, South-East Perth, Sutherland and Ross casual workers are more or less scarce and there is a strong demand for experienced men. In the south large numbers of Irish labourers are being employed.

Agricultural Returns, 1926.

THE Preliminary Statement of the Agricultural Returns taken in Scotland on 4th June 1926 shows that the total area under crops and grass amounts to 4,696,000 acres, comprising 3,205,000 acres of arable land and 1,491,000 acres under permanent grass. The total acreage is the smallest recorded since 1878, while the area of arable land is the smallest recorded since the Returns were first taken in 1866, being less than in 1925 by 24,000 acres. The area under permanent grass has, however, increased by 15,000 acres, and the diminution in the total area under crops and grass is thus 9000 acres.

The area under rotation grasses and clover, 1,494,000 acres, has decreased by 8,400 acres, while the area under other specified crops is 15,700 acres less than in the previous year. The total decrease is mainly accounted for by barley, turnips and swedes, and bare fallow, which combined show a diminution of 33,400 acres. Wheat, oats, vetches and sugar beet all show increases.

The area under wheat, 52,800 acres, is greater by 4,200 acres than in 1925, that under barley, 126,000 acres, is the smallest ever

recorded, and less by 26,900 acres than that of last year; while that under oats, 937,000 acres, is 11,000 acres greater than in 1925 Mixed grain and rye show decreases of 300 acres and 150 acres respectively, while the areas under peas and beans to be harvested are unchanged.

Potatoes, with an area of 142,000 acres as compared with 142,150 acres in 1925, are under the average of the preceding ten years by about 7,500 acres. The area under turnips and swedes, 391,500 acres, is less than last year by 4,500 acres and is the smallest ever recorded.

Mangolds and small fruit show small increases, while the areas under cabbage and rape have decreased somewhat. Sugar beet, which increased from 4 acres in 1923 to 1,500 acres in 1925, now shows a total area of 3,000 acres. Of the crops for which returns are made, but which are not separately shown in the accompanying table, all show slight increases in area except flax, which has decreased by about 100 acres.

Of the whole area under permanent grass, 163,000 acres were cut for hay and 1,328,000 acres were grazed, while of the area under rotation grasses and clover 413,000 acres were cut for hay and 1,081,000 acres were grazed. The area under permanent grass for mowing was greater than in 1925 by 7,000 acres, and that under rotation grass for mowing by 10,000 acres; the total area cut for hay is thus greater by 17,000 acres.

The live stock returns show that horses, cattle and pigs have diminished in number, while sheep have increased.

Horses used for agricultural purposes, numbering 132,500, are fewer by 4,150, the total being the smallest since 1915. Unbroken horses of one year and above are fewer by 1,750 or 8·2 per cent., while foals show an increase of 750 or 12·9 per cent., this being the first increase in numbers since 1920. The total decrease in horses is 5,700 or 3·1 per cent.

The total number of cattle, 1,196,500, shows a decrease of 8,300 or 0·7 per cent. The numbers of cows in milk, heifers in calf, and other cattle under one year are greater than in 1925 but the remaining classes show decreases. The increase of 6,700 in cows in milk is almost balanced by a decrease in cows in calf of 6,050. Bulls being used for service have decreased in number since 1925 by 200, feeding cattle over 2 years old by 15,900, and yearling feeding cattle by 9,700. Calves show an increase of 12,850.

Ewes, which number 3,107,850, show the highest total ever recorded, and are more numerous than in 1925 by 51,950. The number of lambs, 3,028,400, is greater than last year by 97,550. Rams show an increase of 1,250 and other sheep one year and above a decrease of 80,590. The total number of sheep, 7,188,600, is 69,800 more than last year, and is the highest recorded since 1910.

Sows and boars are more numerous by 1,800 and 150 respectively, while other pigs have decreased by 10,200, the total pig population being 145,950, as compared with the record high figure of 198,800 in 1924 and 154,200 in 1925.

It should be noted that the figures given above and in the following tables are subject to revision.

AGRICULTURAL RETURNS FOR SCOTLAND, 1926.

Preliminary Statement for 1926, compiled from the Returns collected on 4th June, and comparison with 1925. The figures for 1926 are subject to revision.

CROPS AND GRASS.

Distribution.	1926.	1925.	Increase.		Decrease.	
	Acres	*Acres.*	*Acres.*	*Per Cent.*	*Acres.*	*Per Cent.*
Total Area (excluding Water)	19,069,683	19,069,683	..	..	..	..
Total Acreage under all Crops and Grass (*a*)	4,696,000	4,705,000	..	..	9,000	0·2
Arable Land	3,205,000	3,229,000	..	..	24,000	0·7
Permanent Grass (*a*) — For Hay	163,000	156,000	7,000	4·5	..	..
Permanent Grass (*a*) — Not for Hay ..	1,328,000	1,320,000	8,000	0·6	..	..
Permanent Grass (*a*) — Total ..	1,491,000	1,476,000	15,000	1·0	..	..
Wheat	52,800	48,600	4,200	8·6	..	..
Barley (including Bere)	126,000	152,900	..	..	26,900	17·6
Oats	937,000	926,000	11,000	1·2	..	..
Mixed Grain	1,700	2,000	..	..	300	15·0
Rye..	5,200	5,350	..	..	150	2·8
Beans (to be harvested as Corn)	3,400	3,400	..	..	..	..
Peas	500	500	..	..	..	..
Potatoes	142,000	142,150	..	..	150	0·1
Turnips and Swedes	391,500	396,000	..	..	4,500	1·1
Mangolds	1,100	1,000	100	10·0	..	..
Cabbage	4,000	4,100	..	..	100	2·4
Rape	12,500	12,600	..	..	100	0·8
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder	12,000	10,600	1,400	13·2	..	..
Sugar Beet	3,000	1,500	1,500	100·0	..	..
Small Fruit	7,600	7,200	400	5·6	..	..
Rye-grass and other Rotation Grasses and Clover — For Hay	413,000	403,000	10,000	2·5	..	..
Rye-grass and other Rotation Grasses and Clover — Not for Hay ..	1,081,000	1,099,400	..	..	18,400	1·7
Rye-grass and other Rotation Grasses and Clover — Total	1,494,000	1,502,400	..	..	8,400	0·6
Other Crops	3,700	3,700	..	..	..	..
Bare Fallow	7,000	9,000	..	..	2,000	22·2

LIVE STOCK.

	1926.	1925.	Increase.		Decrease.	
	No.	*No.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
Horses used for Agricultural purposes (including Mares for Breeding)	132,500	136,650	..	..	4,150	3·0
Unbroken Horses (including Stallions). — One year and above ..	19,600	21,350	..	..	1,750	8·2
Unbroken Horses (including Stallions). — Under one year ..	6,550	5,800	750	12·9	..	..
Total	158,650	163,800	..	..	5,150	3·1
Other Horses	21,050	21,600	..	..	550	2·5
Total of Horses	179,700	185,400	..	..	5,700	3·1
Cows in Milk	355,000	348,300	6,700	1·9	..	..
Cows in Calf, but not in Milk..	43,750	49,800	..	..	6,050	12·1
Heifers in Calf	56,200	52,200	4,000	7·7	..	..
Bulls being used for Service	17,200	17,400	..	..	200	1·1
Other Cattle :—Two Years and above ..	220,200	236,100	..	..	15,900	6·7
,, ,, One Year and under two ..	267,200	276,900	..	..	9,700	3·5
,, ,, Under one year	236,950	224,100	12,850	5·7	..	..
Total of Cattle	1,196,500	1,204,800	..	..	8,300	0·7
Ewes kept for Breeding	3,107,850	3,055,900	51,950	1·7	..	..
Rams to be used for Service in 1926	87,600	86,350	1,250	1·4	..	..
Other Sheep :—One year and above	964,750	1,045,700	..	..	80,950	7·7
,, ,, Under one year	3,028,400	2,930,850	97,550	3·3	..	..
Total of Sheep	7,188,600	7,118,800	69,800	1·0	..	..
Sows kept for Breeding	17,950	16,150	1,800	11·1	..	..
Boars being used for Service	2,000	1,850	150	8·1	..	..
Other Pigs	126,000	136,200	..	..	10,200	7·5
Total of Pigs	145,950	154,200	..	..	8,250	5·4

(*a*) Excluding Mountain and Heath Land used for grazing (9,782,532 acres in 1926, as compared with 9,643,996 acres in 1925).

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions. Full references to the original publications may be obtained on application to the Secretary, Board of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Seed Disinfection: Experiments with Mangold and Sugar-Beet Seed. *Tidskrift for Planteavl. Haefte*, 1926.—*Root-rot.*—When May is cold and rainy, and when the soil forms a crust, root-rot may necessitate resowing or cause losses approaching half part of the crop. Retardation due to deficiency in lime or fertilisers, to cold, or to formation of a crust, appears to be the decisive factor, allowing the disease to spread among the young plants.

Crown-rot (Dry rot).—This disease is interpreted as being caused by *Phoma betæ*, but as being strictly dependent on drought and high alkalinity of the soil. The disease is not prevented by seed disinfection.

Steeping in water may stimulate germination, but the effect is frequently only temporary and not sufficient to control root-rot. The stimulated germination following chemical disinfection is not due solely to the steeping, since the germination of seed disinfected by dusting may be equally accelerated. Hot water treatment was insufficient and dangerous to germination.

Formaldehyde, hydrochloric and sulphuric acid (followed by neutralisation by lime) had some effect, but were not to be recommended for practical use; lime, copper sulphate, corrosive sublimate and certain other disinfectants were also not recommended.

Particulars, however, are given of some which caused a remarkable increase in the number of plants and appeared to afford a considerable degree of protection against root-rot.

Sugar-Beet Breeding at Svalof: Methods and Breeding Principles. *Sveriges Utsädesförenings Tidskrift, Argang, XXXV. Hafte* 6, 1925.—The author describes the methods and principles of breeding sugar-beet at Svalof.

1. The most desirable roots are chosen by eye, and those which possess a high sugar content as shown by polarisation are selected as seed parents.
2. It has been found that such strains as are obtained through hybridisation of different lines or families give as a rule a better yield in comparison with strains obtained from family breeding and mass selection.
3. The lines evolved by Professor Nilsson through inbreeding—except the Nidus type—did not produce as high a yield as the strains obtained from mass selection.
4. There are at least three different leaf forms, and these have been named "Nidus," "Incurvata" and "Adpressa."
5. The results obtained by analysing plants from lines of different leaf forms show that with reference to the rosette types the relation of weight of green matter to weight of roots is correlated to sugar content, and also that the Nidus types, so rich in leaves, have generally given the greatest yield of sugar per root as well as per unit of area.
6. It is concluded that the breeding of sugar-beet may be carried out by means of family breeding combined with hybridisation or by inbreeding.

Preservation of Silage. *Koch, L., Algemeem Landbouwweckblad voor Nederlandsch Indie. Baandoeng*, 1924.—After the forage has been in the silo for four to five months, the loss is 10 per cent. The carbo-hydrates undergo a great diminution; on the other hand the fat content is greater, probably because the bacteria transform the carbo-hydrates into fats. The results are similar to those obtained in America.

A Census of an Acre of Corn (by Sampling). *F. L. Engledow, M.A., Journal of Agricultural Science, Vol. XVI, Part 2, April* 1926.—Gradations of spacing or density occur in the plant populations of crops; vermin, disease and other factors influence this condition. As regards population density a field is a vast aggregate of little plots in which plants are spaced to various degrees. Population density is one of many factors governing yield.

It was impossible to count all the plants in an acre of corn and the census

was therefore taken by "sampling." 100 samples each of one foot length of drill were drawn from a chosen acre.

The crops on which the census was made were Yeoman wheat, Little Joss wheat and Spratt Archer barley.

The practical aspects of the investigation and the bearing of the census results on small scale field trials are discussed. Census counts have a certain recommendation as a basis of experiment. That they may serve as estimates of the yield per acre is shown. From the Yeoman field the crop was 22½ bush. of head grain against the census estimate of 23½ for head and tail. In the case of the Little Joss field corresponding values were 50 and 52 bushels.

Plant development and yield per unit area show well-defined relationships to spacing. The yield from any small length of drill is affected by the populousness of the other small lengths it adjoins and those it confronts in neighbouring drills. In connecting up the variations in spacing and the consequential effects on plant development with certain husbandry practices, the disadvantages besetting experiments at wide regular spacing and with a care in sowing beyond what is possible in practical husbandry are shown.

SOILS.

Influence of Lime and Phosphatic Fertilisers on the Phosphorous Content of Soil Solution and of Soil Extracts. *F. W. Parker and J. W. Tidmore, Soil Science, Vol. XXI,* 6.—Experiments are described which were carried out to investigate the influence of lime and phosphatic fertilisers on the phosphorus content in the soil solution and soil extracts.

The soil solutions and extracts were examined for phosphate content by means of a very simple, rapid and accurate method. It was found that the phosphorus content of the soil solution and soil extracts from unfertilised plots was materially increased as a result of heavy liming, and hence the liming appears to make the native soil phosphorus more available to plants.

When phosphates, such as acid phosphate or basic slag, were added to the soil with and without lime, it was again found that there was a considerable increase in the phosphate content of the soil solution and extracts obtained from the limed plots. Rock phosphates and steamed bone meal were also used as sources of phosphate, but it was found that with the former the increased solubility effect was not so marked, and, with the latter, liming was observed to have a depressing effect upon the availability of the phosphorus.

Aluminium and Acid Soils. *J. Line, Jour. Agric. Science, XVI,* 3, 335 (1926).—In this paper the author discusses the "toxic aluminium theory" of acid soils, and points out that results obtained during his researches do not confirm the view that appreciable quantities of soluble aluminium are found in acid soils, and that this aluminium has a toxic effect on the plant. He points out that except in abnormally acid soils the aluminium cannot remain in solution.

The author attributes the depression of plant growth in culture solutions containing an aluminium salt to precipitation of phosphate and hence phosphate starvation, or to increased acidity due to hydrolysis of the salt, which the plant is unable to counteract. In the case of soil this phosphate starvation does not occur, as the plant appears to be able to get its phosphate from a salt of aluminium as well as from a salt of calcium when the roots are in intimate contact with the salt particles.

The application of lime or phosphates to soils of this acid type appears to be beneficial only from the point of view of reducing acidity and supplying plant nutriment, and not from the point of view of precipitating, and hence removing this soluble and supposed toxic aluminium.

Researches on Soil Reaction and the Cartography of the Degree of Acidity in the Fields of the Experimental Farm of the College of Agriculture and Sylviculture at Prague at Netluky Uhrineves. *A. Nemec and M. Gracanin, Abstracts of Proceedings of International Society of Soil Science, II,* 2, 164 (1926).—No soils of extreme acidity were found, and there appeared to be no precise relationship between the total lime content and the soil reaction, but the most acid soils contained the lowest amount of lime.

The influence of manures applied in recent years was studied, and it was shown that portions of the farm manured with physiologically alkaline manures (carbonate of lime, nitrate of soda, basic slag and farmyard manure) tended to

have a more basic reaction than those which were treated with physiologically acid manures (sulphate of ammonia and kainit).

Yields of sugar-beet on acid soil were found to be poor, and with decreasing acidity the yields of beet increased. Wheat and barley yields also varied inversely with the acidity of the soil, whilst oats and potatoes appeared to do best under acid conditions.

Chemical Method of Determining Phosphoric Acid Requirements of Agricultural Soils. *A. Nemec, Compt. rendus*, 183, 314 (1926).—A rapid colorimetric method of determining soluble phosphoric acid has been applied to soils and the results compared with the yields obtained in field trials.

It was shown that soils required to contain 35 mg. of phosphorus per kg. dry soil for sugar-beet. 22 mg. for barley, 19 mg. for potatoes and meadow land and 5 mg. for oats. Soils containing less than the above amounts required phosphatic fertiliser.

FERTILISERS.

Austria: Regulation of the Trade in Chemical Fertilisers.—To meet the difficulties of the marketing of these fertilisers and to protect the farmer against commercial frauds, the Federal Minister of Agriculture and Forestry for Austria has issued a decree which lays down special rules for the trade in the products in question. The terms of the decree cover all materials which are not the immediate product of the farm, but which on account of their content in nitrogen, phosphoric acid, potash, lime and other chemical constituents are placed on the market as artificial fertilisers. These artificial manures may be put up for sale only after declaration of their properties and of the weight of their effective chemical constituents. Generally speaking, the declaration, in addition to the usual commercial indications, must contain information on the value in fertilising substances and on the form in which they are found in the products as placed on the market.

In the case of calcareous fertilisers the grade of fineness must also be indicated, and in that of fertilising mixtures the nature of the blend and the form under which the effective constituents are present. In the case of those products that are placed on the market with the indication that, in addition to their usual commercial value, they are in some special way favourable to plant development, the nature and character of this particular action must be clearly indicated.

Declarations are regarded as valid if the differences do not exceed one per cent. and in the case of nitrogenous fertilisers one half per cent. of the true content in fertilising substances.

The political and district authorities and the Agricultural Experiment Stations are responsible for supervising the application of the measures enacted. The stations are also authorised to take samples for analysis and to make use of a staff sworn in for the purpose and subjected to professional secrecy.—(*Bundesgesetzblatt*, No. 88, 1925.)

ANIMAL BREEDING.

The Seasonal Sex-Ratio in the Pig. *A. S. Parkes, Zeit. indukt. Abstamm. Vererb.*, *v.* 40, 1926.—The data are based on the National Duroc-Jersey Record, v. 67. The year was divided into quarters: September to November, December to February, March to May, June to August. Of 10,961 births recorded, 5,007 were males and 5,954 females for the whole year, giving a male percentage of 45·6. More than half these births occurred during the March to May quarter, but in spite of this no significant variation in the sex-ratio was found. The male percentages for this and the three successive quarters were respectively 46·1, 45·4, 45·2, 44·4. The author therefore concludes that in this breed of pig no seasonal variation in the sex-ratio occurs.

Inheritance of Spotting in Friesian Cattle. *E. Lauprecht, Zeit. f. indukt. Abstamm. Vererb.*, *v.* 40, 1926.—A study of the inheritance of spotting in three large herds of Friesian cattle in Holland and North Germany. The author states that there are six definite centres of white—above the eye and cheek, above the ear and back of head, the neck, upper portion of fore leg, the middle region of the body around the last ribs, and the hocks of the hind legs. After a lengthy explanation and description he comes to the conclusion that a mating of two dark Friesians will not produce a light one, while a mating of two light ones will not produce a dark one, although medium-spotted individuals

are produced in all cases. This serves to confirm the view of several other investigators that the inheritance of spotting in the Friesian is due to multiple factors, being what is known as "blending inheritance." There is no evidence that sex in any way affects the markings.

The Inheritance of Teats in Pigs. *H. Nachtsheim, Deut. landw. Tierzucht, vol.* 29, 1925.—The author studied 1000 offspring of eight boars, one of which was a wild type. The average number of mammæ possessed by individuals varied from 10 to 17, and averaged 12·97. The progeny of the different boars varied considerably. The male offspring had as many teats as the female, and the males were considered as important in the determination of the number of mammæ in the offspring as were the females. There was little or no correlation between litter size and number of mammæ.

A Fertile Mule. *H. Henseler, Deut. landw. Tierzucht, vol.* 29, *pp.* 245-253, 1925.—A mare mule proved fertile, giving four foals, two to jacks and two to stallions. Her first foal was sired by a jack, the mare having previously been bred to a stallion without results. The colts sired by stallions resembled horses, while those sired by jacks were mule-like.

Previous well-authenticated instances of this have already been recorded.

Causes of Variation in Milk Records. *J. Hammond and H. G. Sanders, Jour. Bath and West and South Counties Soc.*, 1924-25.—From a study of milk records in Norfolk and Cumberland it was found that, except for Friesian, the mongrel shorthorn cattle are better milkers than any of the pure breeds. Cows which calve during autumn and winter months yield more milk on the average than those which calve in the late spring, owing, in the opinion of the writers, not so much to the demands of the fœtal calf as to the changes in the udder of the cow. The drop in yield occurs at about the fifth month of pregnancy, the udder at this time starting to grow in preparation of the next pregnancy. The records for the Penrith Society show that if the cow was dry less than 40 days before calving, she gave on the average 13 per cent. less than the normal during the next lactation period. For a dry period beyond six weeks there was little, if any, compensation.

The age of the cow affects her yield. The Penrith records show that the maximum yield is attained with the fifth calf, and that on the average 30 per cent. has to be added to a first calf heifer's yield to bring it up to this maximum.

The reason why cows calving in certain months (November) give better yields than those which calve in other months (June), appears to be that the June calver comes in flow at the end of the spring flush of grass, but as the grass grows she falls off rapidly in her yield and continues to do so when put on winter feed. The November calver comes down on winter feed, is fairly steady throughout the winter, and just as her yield begins to drop is turned on to the fresh spring grass, resulting in increased flow. The most favourable time for calving will no doubt vary with locality. It is believed, however, that the general trend is the same in all districts, i.e. high yield from late autumn and winter calvers, and low yield from spring and summer calvers.

Ovarian Implantation in Presenile Cows. *Staheli, A., Schweis. Arch. f. Tierheilk., vol.* 82, 1925.—With a view to regenerating aged dairy cows in order to increase and prolong lactation, the reproductive organs of young heifers were grafted on to 51 aged cows. Thereafter, although most of the cows had refused the bull for nearly a year, 46 came in season and were mated. Of these 31 conceived, while 15 were mated again and produced a second crop of calves.

The technique of the operation appears to be fairly simple. No reference is made, however, to the comparative milk yields before and after the graft.

ANIMAL NUTRITION.

Calcium and Phosphorus Metabolism in Dairy Cows. *Meigs, E. B., and Others, Jour. Agri. Res., XXXII, No.* 9, *May* 1926.—In this paper the results of two metabolism experiments are reported. In the first the main objects were to determine whether calcium and phosphorus equilibrium could be maintained in milking cows at different levels of milk yield, and on rations which included alfalfa hay of known origin and history; also to throw some light on the question of the effects on calcium and phosphorus metabolism of various parts of the experimental procedure necessary in carrying out balance experiments.

The object of the second experiment was to obtain further information on the extent to which cows can assimilate calcium and phosphorus from alfalfa hay cured in different ways; to observe the effects on calcium and phosphorus metabolism and on milk yield of a long period on a diet deficient in calcium; to get some idea of the extent to which a cow may lose calcium and phosphorus from her body; to find out whether the state of the calcium and phosphorus stores has any marked effect on the rate at which their elements are assimilated from a given diet; to observe the effects of cod liver oil on calcium and phosphorus assimilation, and to get some idea of the extent to which calcium and phosphorus metabolism are dependent on one another.

The paper is a lengthy one giving the exact methods of the experiment and the various rations used. The results are summarised as follows :—

Experiment I.—The assimilation of calcium by dairy cows is likely to be greatly interfered with by any influences, such as disturbances in habit and routine, which throw them even slightly off their feed.

When the cows used in the experiment were not disturbed by changes in routine they assimilated from 15 to 20 per cent. of the calcium in the ration, the calcium content of which was supplied by inferior alfalfa hay.

Experiment II.—The changes in the calcium and phosphorus content of the bodies of milking cows do not run exactly parallel. A cow may continue to lose one element from her body and gain the other for a period of two or three weeks. Nevertheless the results show that a long continued loss of calcium from the body will cause a roughly corresponding loss of phosphorus.

The rate of calcium assimilation from hay depends very largely on the manner in which the hay is treated after being cut. Calcium is very poorly assimilated from hay which has been exposed to rain. The average proportion of calcium assimilated by milking cows from fairly well cured hay is about 20 per cent. of the intake. The addition of cod liver oil had no favourable effect on milk yield. The milk yield in these experiments showed a tendency to fall off more rapidly when rations were deficient in assimilable calcium.

The writer suggests that phosphorus assimilation may be interfered with by an excess of calcium in the ration, and that two parts or more by weight of calcium to one of phosphorus constitute an excess.

Staffordshire Farm Institute Feeding of Pigs: An Experiment with Mineral Salts. *Reprint from the Farmers' Advocate, London, Ont.*—An experiment was carried out to determine the value for growth and the effect on the size of the subsequent litters of potassium iodide, a constituent of the mineral supplement used for all classes of pigs at the Farm Institute.

Three groups of three pedigree large white gilts, alike as regards age and breeding, were used. All received a ration consisting entirely of vegetable meals without any addition of fish or flesh. The first group received in addition a supplement of the complete mineral mixture consisting of steamed bone flour 15 lbs., carbonate of lime 20 lbs., flowers of sulphur 15 lbs., wood ashes 15 lbs., salt 35 lbs., and potassium iodide 5 ozs. In the second group the potassium iodide was omitted from the mineral mixture, while the third group received no extra mineral matter.

For the first 232 days the average daily increases were: Pen A 1·08 lbs., Pen B 1·01 lbs., Pen C 0·95 lbs. The poor rate of growth is attributed to the fact that the pigs had no animal protein. At farrowing it was found that Pen A gave an average of 9, Pen B 6 and Pen C 7·5 pigs per litter.

The author concludes that confirmation is given to the view held in some quarters that increase in the supply of calcium without a corresponding increase of iodine is detrimental to growth.

Whale Meat Products as Food for Pigs. *Golding, J., and Morris, W. B., Journ. Min. Agri., XXXIII, No. 6, August* 1926.—This article gives an account of a series of experiments to test the feeding value for pigs of some whale meat products. These consisted of "whale meat meal," which has been subjected to considerable heat in its preparation, and of "whale meat flakes," prepared at a much lower temperature. A comparison was made both for bacon and pork production between these products and fish meal, and experiments were also carried out to test whether the whale products, which contain considerable amounts of oil, tainted the bacon in any way.

Upwards of 100 pigs have been used for experimental purposes, and it has been found that, judging by the live weight increases, whale meat meal was

slightly inferior to white fish meal, but the whale meat flakes were, throughout, superior to fish meal. When the amounts of food consumed per lb. live weight increases were compared these results were confirmed. The pigs fed on whale meat were ready for the butcher earlier than the others, and showed a finer bloom. The pork and bacon were subjected to test for taint, but in no case was an adverse report received.

Extracted, as compared with non-extracted, whale meat and whale oils were also fed to pigs, but there was no evidence of any taint, while the fat was found to be harder. Sows when fed on a diet containing 10 per cent. whale meat flakes produced good litters, and good results were also obtained during the lactating period.

The Value of Dairy Products in Pig Feeding. *Morris, W. B., National Institute for Research in Dairying.*—A short account is given of experiments in feeding pigs with dried separated milk. Dried separated milk is obtainable in the form of a white powder which mixes readily with water and gives a reconstituted product closely resembling the original milk.

In these experiments with young pigs, ¼ lb. dried separated milk per pig per day replaced a part of a mixture composed of crushed barley, 60 per cent.; sharps, 20 per cent.; and extracted palm kernal meal, 20 per cent.

In the first experiment two groups of pigs were used with the following results:—

Basal food consumed	631 lbs.	718 lbs.
Dried separated milk consumed	34 lbs.	...
Total live weight increase in 34 days ...	177 lbs.	168 lbs.

Thus 34 lbs. dried separated milk gave 9 lbs. more live weight increase than 87 lbs. of the basal mixture.

The second experiment confirmed the above result, 44 lbs. of dried separated milk producing 16 lbs. more increase in live weight than 62 lbs. of the basal ration. In both experiments the pigs receiving the dried separated milk showed a very much superior general condition.

The Composition, Digestibility and Feeding Value of Hydrolyzed Sawdust. *Archibald, J. G., Jour. Dairy Sc., Vol. IX, No.* 3, *May* 1926.—Results are given of an investigation into the feeding value of hydrolyzed sawdust at the instigation of the Forest Products Laboratory of the U.S. Department of Agriculture. The treatment of the sawdust consists in cooking it under 120 lbs. pressure with dilute sulphuric acid, which converts a portion of the cellulose and allied substances into sugar. The liquor resulting from the digestion together with the washings from the undigested sawdust residue is neutralized with lime and evaporated to a syrup.

As a result of analysis, hydrolyzed sawdust was found to be almost entirely composed of crude cellulose, lignin, and a mixture of hexose and pentose sugars. In experiments with cows it was found that the animals would not eat the hydrolyzed sawdust when fed by itself. In order to promote consumption the sawdust had to be mixed with grains. About 4 lbs. daily is all that the mature dairy cow will consume.

Digestion studies showed a variation in the percentage digestibility of the dry matter of hydrolyzed sawdust from different species of tree—46 per cent. in the case of the Eastern White Pine and 33 per cent. for the Douglas Fir.

On the basis of equal amounts of digestible nutrients, the sawdust when fed to dairy cows produced only slightly smaller amounts of milk than did corn starch, but it took, on an average, 2·75 lbs. of sawdust to equal one pound of starch.

The Significance of Copper, Manganese and Zinc in Forage Crops and Foods. *M'Hargue, J. S., Journal of American Society of Agronomy, Vol. XVII, No.* 6. *Geneva, N.Y.*, 1924.—The object of the article is to present data showing the occurrence and proportion of copper, iron, manganese and zinc in certain plant products and to draw attention to their significance.

Fertile soils contain small amounts of copper, manganese and zinc, which are absorbed to a slight extent by plants and stored in the leaves, pericarps and germs of the seeds. When maize, wheat and rice are highly milled, the resulting meal, flour and polished rice are deprived of the greater part of the compounds of copper, iron, maganese and zinc, which appear to be factors in animal nutrition. Some depleted soils may require the addition of small

amounts of copper, manganese and zinc in order to restore and maintain productivity, and to produce a food supply containing the vital factors in normal proportion.

The Partial Replacement of Hay by other Foods. *De Ruyter De Wildt, J. C., and Brouwer, E., Verslagen van landbouwkundige onderzoekingen der Rijkslandbouwproefstation, No. XXIX. The Hague*, 1924.—The authors have tested the effect of replacing about two-thirds of the ration of hay by a mixed food of composed "Tarwegrint" (a milling by-product similar to bran) and maize meal with pea and oat straw. The test was made on the milk production of dairy cows.

The result of such replacement in a mixed diet was that no influence could be noticed either on the weight of the cows or on the quantity and composition of the milk. From calculations made, it is concluded that in the winter of 1922-23, in a period of scarcity of hay, the above replacement caused a saving of 135 florins per 1000 kg. of live weight in a stall period of 180 days.

The effect of Fat in the Ration upon the percentage Fat Content of the Milk. *W. B. Nevens, M. B. Alleman and L. T. Peck, Journal of Dairy Science, vol.* 9, *No.* 4, *July* 1926.—A series of trials was conducted in which rations high in fat were compared with rations low in fat. The comparisons made were high fat grain mixtures with low fat grain mixtures; soybeans with soybean oil meal; flax-seed with linseed oil meal; peanuts with peanut oil meal; linseed oil meal plus linseed oil with linseed oil meal; peanut oil meal plus peanut oil with peanut oil meal; and soybean oil meal plus soybean oil with soybean oil meal.

The feeding of general grain mixtures high in fat had no influence on the fat content of the milk in one series of trials, but in another increased it by 8 to 18 per cent., while in the soybean trials no significant changes were found. Flax-seed, when compared with linseed oil meal, increased the fat content of the milk by 10 per cent., and the addition of linseed oil to a linseed oil meal ration increased it by 12 per cent. Peanuts gave a 9 per cent. greater fat content than peanut oil meal, and the addition of peanut oil to a peanut oil meal ration increased the fat content of the milk by 12 per cent. Both the linseed and peanut oils increased the total yield as well as the percentage of butter fat.

Where increases in fat percentage were induced they usually started 12 to 36 hours after the fat content of the ration was increased, lasted for 2 or 3 days, and then decreased.

The effect on Milk Production of feeding more than the Haecker, Eckles and Savage Requirements. *H. T. Converse, Journal of Dairy Science, vol.* 9, *No.* 4, *July* 1926.—The results of short and long-time trials indicate that feeding more than is called for by the feeding standards increases production. In two short-time trials a 16 per cent. increase in milk yield was obtained on feeding 12 per cent. more than the standard requirements, while in trials lasting throughout the lactation periods of the cows increases of 14 to 16 per cent. in milk yield were obtained on increasing the ration to 17 per cent. above the requirements of the standard.

DAIRYING.

Some Factors influencing Cream Rising. *Palmer and Anderson, Journal of Dairy Science*, 9 (1), 1.—From a study of the physico-chemical factors influencing the creaming of milk, the authors arrive at the following conclusions:—(1) the volume of cream rising on raw milk is determined largely by the content of solids-not-fat; (2) that the viscosity of raw milk is a good index of its creamery ability, but that the viscosity of pasteurised milk is only a minor factor in determining the cream layer on pasteurised milk; (3) the fundamental factors which lead to a diminished cream line on pasteurised milk have yet to be determined.

Factors affecting the Growth of Blue Mould in Cheese. *N. S. Golding, Journal of Dairy Science*, 9 (1), 28.—Citric and acetic acid have a direct bearing on the growth of *P. roqueforte*—the blue mould commonly found on Roquefort, Stetton and Wensleydale cheeses. The type of starter used in making blue-veined cheeses may possibly have an effect on the growth of blue mould.

Consumption of Milk and Cream in United States. Published statistics show that in the year 1924 there was consumed in the United States 52,772,000,000 pounds of milk and cream, corresponding to an average daily

consumpt per individual of 1·2 pints. The figures show that there has been a marked increase in recent years in the amount of milk consumed by the population. The reasons given for this increase are: (1) propaganda and advertising; (2) delivery of milk and cream in sealed containers which are sanitary, neat and convenient.

Seasonal Variations in Certain Constituents of Milk. *A. Blanchetiere, C.R.S. Soc. Biol.*, 92, 1295.—B. examined a series of samples of milk supplied to the hospitals at Lens with reference to their content in selected minerals. He found that the alkaline constituents diminish, but that the alkaline earth components increase in winter-time. He states that these differences cannot be due to the variations in the mineral content of the food. He suggests that the greater ingestion of vitamin A from summer pastures causes a greater fixation of calcium in the organism.

Condensed Fermented Skim Milk. *Milk and Creamery Plant Monthly, Aug.* 1926.—This product, which is analogous to and practically identical with semi-solid butter-milk—a product which is coming into increasing favour in this country with poultry-keepers and for the feeding of dairy calves—is made by fermenting skim or separated milk with a starter containing a large yeast, v. *B. bulgaricus*, until the acidity reaches 2 per cent. lactic acid, and condensing the fermented milk by the vacuum process in the ratio of 3 : 1. The finished product, which is a pasty semi-fluid mass, has an approximate acidity of 6 per cent., and keeps in good condition for a lengthened time. It has been used with success in feeding baby chicks (in a dilution of 1 : 8) and laying hens (1 pound paste to 1 pound dry mash).

France: A Permanent Committee for Milk Testing.—This Committee has been established by the *Société nationale d'encouragement à l'agriculture* and is formed by a combination of the Testing associations already in existence. The object of the Committee is to encourage the diffusion of the testing system, and to keep the associations thus combined informed of all that has been done in the matter and of all results obtained with a view to the establishment of further testing work. At the end of 1925 the Committee had extended its work to 13 breeds of cattle, and 16 associations were formed for testing of the Norman breeds and 15 for the Flemish breed, whether exclusively or at the same time as other breeds.—(*La Vie Agricole et Rurale, Year* 14, *Vol. XXVII., No.* 49. *Paris*, 1925.)

LIVE STOCK:—*Pigs.*

Report on Comparative Experiments with Pigs from State-aided Pig Breeding Centres. *Lund, A., Beck, N., Rostinf, P., Beretning fra Forsogslaboratoriet. Copenhagen*, 1925.—The report describes investigations made during the period September 1st, 1923, to August 31st, 1924, at the three Pig Experimental Stations: *Bregentved, Elsesminde* and *Over-Lojstrup*, the purpose of which was to study the fattening and butchering qualities of the pigs coming from the State-aided centres and fed at the stations.

In Denmark we find practically two breeds of pigs only: the Danish Country Breed and the Yorkshire Breed (the Large White). There are a number of breeding centres for each of these races in Denmark, the purpose of which is to produce pure-bred animals. The foundation of the centres, which goes back more than thirty years, is chiefly due to the influence of the Live-Stock Commissioner, M. P. Morkeberg.

The original reason for starting these centres was that Denmark almost forty years ago began to sell bacon to England. The type of pork existing in this country at the time did not possess the qualities demanded by the English bacon market, and to meet this difficulty a search was made throughout the country for animals of the type in request. These animals were then brought to the Breeding Centres, which were in course of time able to distribute good breeding animals all over the country. The fact was, however, that a large percentage of the country-bred pigs—at that time at any rate—suffered from such essential deficiencies (form, fineness) that it was much to be desired that breeding animals of better form should be used for breeding animals for the market. Consequently Yorkshire Breed centres were founded for producing boars, so as to procure—by crossing them with country sows—the real bacon pigs. As a far greater number of sows than of boars are required for breeding, a considerably greater number of centres were established for the native breed than for the Yorkshire breed. The reason for not breeding exclusively from

the Yorkshire is that this breed is considered to be too delicate for the Danish conditions. At present there are in Denmark 161 centres for the native breed and 33 for the Yorkshire breed. The centres must submit to an inspection on the part of the management, who select the animals fit for breeding; the centres obtain a very modest annual subsidy from the Government, and in return bind themselves to keep the necessary herd-books, mark the animals and deliver to the experiment station of the district two pigs every year of the sows chosen. In the course of the years (until the 1st of September 1924) a very great number of breeding animals came from the centres; 27,800 boars and 65,654 sows of the country breed, 10,237 boars and 4,478 sows of the Yorkshire breed were sold.

In estimating the value of the breeding animals selected, especially as regards the fattening and butchering qualities, great assistance is afforded by the figures from the experiment stations. It has been mentioned that the centres are bound to forward to these stations two pigs for each sow chosen; this is done by each separate centre forwarding—after the best boars and sows—a certain number every year of *experimental batches*, consisting of 4 porkers. 6-8 weeks of age, of the same farrow, and preferably 2 boars and 2 sow-pigs Each of the stations, which are spread all over the country, may breed from 100-200 experimental batches every year. The same mode of proceeding is applied everywhere, only certain kinds of grain (barley, oats, wheat in proportion $\frac{1}{3}$-$\frac{1}{3}$-$\frac{1}{3}$) and skim milk being used for feed. The feed is weighed out every day for each batch that has its own sty at the station; every fortnight each pig is weighed, and when the fattening is ended (the pigs on leaving have a live-weight of fully 90 kg.) the consumption of food which for each individual batch has been necessary to produce on an average 1 kg. of growth is estimated in food units. The sufficiently fattened animals are taken to the slaughter-house, and after the slaughtering each animal is submitted to a competent judgment at which various measurements are taken (the depth of the belly, the length of the trunk) and marks are given for characteristics of form, fineness, fleshiness, &c. For 1923-24 the reports from the three experiment stations show the averages given in the table:—

Averages for the Experiment Stations for the year 1923-24.

	Native Breed.	Yorkshire Breed.
Number of animals	1,192	312
Age in day—		
At the beginning	60	63
„ end	184	194
Weight in kilos—		
At the beginning	16·8	15·9
„ end	92·1	91·6
Food units (kgs.) for 1 kg. growth during the time of the experiment	3·59	3·55
At the time of slaughtering—		
Percentage of waste	26·9	25·4
„ offals	12·6	12·6
„ bacon for export	60·5	62·0
Thickness of the pork in cm.—		
In chine	4·2	4·1
„ belly	2·9	3·2
Length of trunk in cm. from hip-joint socket to neck ...	89·5	88·2
Points in (x) judging 0—15—		
Firmness of the pork	12·6	13·5
Thickness and evenness of the chine of pork ...	12·4	12·5
Thickness and fleshiness of the belly	11·5	12·2
Shape and size of the hams	11·9	12·4
Fineness of head, legs and skin	12·4	13·1
Fleshiness	12·2	12·4

(x) 15 = vg, 12 = mg, 9 = g.

The country-bred pigs reached the slaughtering weight ten days before the Yorkshire pigs; the ratio of fatness f.u. to 1 kg. growth was excellent alike for both breeds. The native breed was a little longer in the trunk, but as to quantity of export bacon and quality the Yorkshire breed appears to be superior.

Poultry.

Poultry Farming and Egg Production in Denmark. *Kock, W. A., Publishers, Dyva and Jeppesen, Copenhagen,* 1925.—The difficulties which beset Danish agriculture in the eighties of last century as a consequence of foreign competition and falling prices made many Danes anxious to find new sources of income. One of the most important of the subsidiary activities that were taken up was poultry keeping, with a view to egg production. Now, on many farms, poultry keeping constitutes one of the principal sources of income.

The introduction of Mediterranean breeds has had a great and beneficial influence on the numerical output of eggs in Denmark and also on the size of the eggs themselves. Together with Plymouth Rocks, Wyandottes and Rhode Island Reds introduced from America, the Mediterranean breed of fowls are certainly among those most widely spread throughout Denmark. In 1888 the number of hens, cocks and chickens was 4·5 millions; in 1924, 21·3 millions. Little attention is paid to fattening, while systematic duck breeding is practically unknown in Denmark. There are only a few Turkey breeders, but the breeding of geese is of some importance.

Eggs were exported to England by the regular steam route for the first time in 1865. In 1924 the egg export was third on the list of agricultural products, and amounted to 41·6 million score with a value of 150·8 million Kroner.

In 1895 the Danish Co-operative Egg Export Society was started. The great advantage of this excellent organisation is that it has established the collection and stamping of eggs. Each egg is stamped with a number indicating the producer, which makes it possible to immediately identify suppliers of eggs of inferior quality. The local branches of the society all have their own egg collectors, who make a tour of the members at regular intervals. All eggs are stamped with the trade mark of the Society. They are exported at once, the object of the Society being to furnish foreign markets with only the very best possible newlaid Danish eggs.

One of the most effective means towards development of poultry farming has proved to be the competitions for the best kept and most profitable stocks of fowl belonging to individual members, the aim being to promote poultry breeding on strictly economic lines, no regard being paid to the purely show aspect. From the breeding centres cheap eggs are also distributed for hatching.

The Danish Poultry Breeders Union extends over the whole country. It promotes poultry farming by holding poultry breeding courses, egg-laying competitions, poultry exhibitions; it establishes control stations, issues a monthly paper and gives advice to poultry farmers.

The Breeding Diseases of Poultry, and their Control, with Special Reference to Tuberculosis. *Lerche, M., Deutsche tierärztliche Wochenschrift, No.* 48. *Breslau,* 1925.—The aim of the German farming industry is to become gradually independent of imported supplies of eggs and table fowls. Poultry breeding has on this account become of great importance in the post-war years.

Several diseases are described.

The poultry brood suffers most from tuberculosis. All breeders should regularly have their fowls examined for tuberculosis by means of the intracutaneous tuberculosis test. The tuberculous reaction is 1–11 days after a positive injection, even though diseased processes cannot be microscopically recognised on the organs. A favourable influence can be effected by cold-blooded tubercle bacilli. Specially noticeable is the early revival of laying capacity. What this action depends on is not at all clear; it does not appear to be a specific albuminous action. Warning must be given against indiscriminate inoculation with Friedmann inoculating matter without segregating the diseased fowls, since with this treatment only subjects immune to bacteria remain alive.

Avian Tuberculosis in Mammals. *Plum, N., Publication of the Serum Laboratory of the R. Veterinary and Agricultural High School, Copenhagen,* 1925.—A very thorough study on the above problem, containing exhaustive bibliography. Pages 67-100 deal with previously described cases of spontaneous avian tuberculosis in mammals (human beings, horses, cattle, pigs, and various small animals). In summing up this section, Plum says: Avian tuberculosis in pigs has been so minutely investigated that its significance for this animal can be considered to be cleared up. The significance of this infliction for mankind will be greatly elucidated in a future not too remote. Systematic studies with regard to the horse have been made.

A defect is that in most experiments mammals only have been used and hardly ever hens at the same time.

Mammals are in general infected by ingestion of fæces containing bacilli, or by eating the carcases of fowls.

With man there is always the possibility that he can be infected by eating eggs containing bacilli, for it is proved that the eggs of tuberculous hens can contain bacilli, which are not killed by the usual light boiling.

Whilst formerly the possibility of avian tuberculosis in children was not taken into account, it is now proved that children may be infected spontaneously with ornitho-tuberculosis. Comparatively many of those animals which react to avian tuberculosis have aborted. The pregnant uterus appears therefore to be a place sought eagerly by the ornitho-tubercle bacilli. Animals which abort on account of avian tuberculosis are either not attacked in any other place, or the demonstrable alterations, which take place preferably in the lymphatic glands of the alimentary canal, are very slight. When the avian tubercle bacilli have attacked the uterus, they are able to cause abortion. The bacilli subsequently maintain life in the abscesses which form under the mucous membrane of the uterus, and so later abortion can again take place.

The only rational method for control of avian tuberculosis is to keep in view the source of infection itself, namely, the poultry. Hitherto avian tuberculosis has been allowed to gain ground amongst poultry in a manner completely foreign to the general conditions of care of farm stock in Denmark.

Bacillary White Diarrhœa of Chicks. *Doyle, T. M., Journal of Comparative Pathology and Therapeutics. Vol. XXXVIII, part 4. Edinburgh,* 1925.—Bacillary white diarrhœa is essentially a disease of artificial incubation. It may also occur on farms where only natural methods of hatching are employed, but in such cases it rarely causes any trouble and tends to disappear.

This is partly due to the dark, warm atmosphere of the incubator being favourable for the survival of the causal parasite, while, under natural conditions, the light and temperature have an inhibitory effect and rapidly bring about its death.

As hen-hatched chicks also are continually on the move, the infection is disseminated over a wide area, and the same conditions do not occur as in a crowded brooder house. The fowl is the only species susceptible to natural infection. Many chicks which survive the disease harbour the parasite in one or more of their organs throughout life.

The organism is not a normal inhabitant of the healthy chick. The fact that many chicks which recover harbour the causal agent and are the potential source of future outbreaks is a strong argument against the policy of treatment.

Cold Storage of Eggs. *Morant, T. and Pique, J., Cold Storage and Produce Review, Vol. XXVIII, No. 32. London,* 1925.—Results of researches on the cold storage of eggs made at the Low Temperature Research Station, Cambridge, for the Food Investigation Board of the Department of Scientific and Industrial Research.

(1) Only very fresh, clean eggs, which have not been subjected to a temperature of more than 15·5° C. (60° F.) should be used for cold storage, since at 21° C. (70° F.) a visible development takes place in the egg; even at 16·1° C. (61° F.) embryonic modifications are produced.

(2) The storage temperature should in practice be maintained between 0° C. and +0·5° C. (32° to 33° F.).

(3) To avoid as far as possible loss of weight, the degree of humidity should be kept constant at 80 per cent. and the temperature at 0° C.

(4) To avoid "storage taste" the eggs should be placed on metal plates, or plates rendered impermeable and not susceptible of absorbing odours.

MISCELLANEOUS.

Principles [illegible] Weather Forecasting. *Sanson, J., La Vie Agricole et rurale, Vol. 26, No. 22. Paris,* 1925.—The author discusses some of the principles of practical weather forecasting, chiefly founded on records of the wind and clouds, of animals and plants, with a short note on the atmospheric "parasites" observed by means of radio-telegraphy. The importance which the observation of clouds, especially in recent years, and particularly the higher clouds—usually cirri—heralding the arrival of depressions, has assumed is noted. From these observations it is possible to deduce some general principles which have considerable practical value.

(1) With light winds, variable in direction and with a sky almost free from clouds, with morning mist or abundant dew, there is in all probability an anticyclonic condition (high pressure). A certainty of settled weather is then probable. However, with light southerly winds accompanied by a rise in temperature, especially in the morning, and with high cumuli scattered over the sky, thunderstorms or atmospheric disturbances are to be feared, especially in summer. Regular daily variations in the velocity of the wind, that is to say the passage from a light current in the morning to a more considerable current, coincident with the maximum temperature of the day and with decrease at sunset, indicate a settled condition.

On the other hand a change of weather is to be predicted if in the course of a fine day the wind continues to remain strong in the evening and at night.

Rapidly moving cirri coming from a direction between south and north-west (3rd and 4th quadrants) should give reason to suppose, especially in May and October, that a depression is coming whose centre is situated slightly to the right of the direction from which the clouds come.

These cirri may precede the depression by 24-48 hours, according as the observing station is situated on the edge or in the centre of the nebulous mass; in this case rain or dry weather will depend on the distance of the station from the centre of the depression. The appearance of high cumuli coming from the above-mentioned direction may give similar results.

(2) By forecasting the direction of the wind, it is possible to predict changes of weather. Indeed, for a given place, certain almost constant characters of the weather correspond with the direction of the wind. For each station it is therefore possible to draw up special charts of frequency of the wind according to the various directions, i.e. graphs which illustrate the atmospheric currents apart from their intensity. According to the prevailing directions, observation will disclose types of weather not liable to change while the conditions which have determined them continue.

(3) Certain aspects of the atmosphere also furnish good indications for a local weather forecast. Rain is preceded by exceptional clearness of the air, by better perception of distant sounds (especially those emitted in the direction of rainy winds), by increased twinkling of the stars, by the occurrence of solar and lunar halos (especially the former), by the fact that the clouds are massed in the direction towards which the wind is blowing and by other indications of minor importance which may naturally vary from one region to another, especially in countries round the Mediterranean. The various colorations of the sky at dawn and sunset are also important.

If the sky is pale or grey in the morning, or orange-red in the evening, fine weather will continue; brilliant colorations at dawn almost always indicate rain. A yellow sky at sunset indicates wind, while when the disk of the sun appears to undergo certain characteristic deformations it is always a sure sign of rain.

Other chromatic indications, useful in forecasting, were recorded centuries ago as popular ideas based on experience, such as formed the subject of poetic treatment in Virgil's Georgics, and have been taken up recently, developed and propounded by Father Paoloni of Montecassino as an aid to weather forecasting under the title of "Virgil's Method." The observation of the higher air currents, determinable by observation of clouds, can also furnish useful indications for forecasting. If the wind below becomes stronger and the higher clouds travel in the opposite direction, or in a direction forming a fairly wide angle, it may be predicted that the wind below will give place to the higher current. Two winds succeeding each other in opposite directions almost always bring rain. Generally, rain may more easily be predicted the more superimposed strata of clouds are present in the sky. Settled clouds in the direction whence the wind blows only bring a continuation of the same air current; if on the other

hand they appear in the opposite direction, they announce the termination of . When clouds collect from different directions, they indicate a thunderstorm; clouds collecting on the slopes of a mountain indicate rain.

(4) Certain animals are able to give indications regarding change of weather; thus the behaviour of cats and birds on the approach of rain is known. On the approach of bad weather flies become more troublesome, and sea-birds come in greater numbers to the coast and fly lower. On the other hand, with fine weather, swallows fly higher, butterflies are more numerous, spiders weave their webs more actively, and flies fly even after the sun has set. Certain plants also can indicate the coming state of the weather, and both in the case of animals and plants such behaviour is explained by variation of the hydrometric condition of the air when the change of weather is indicated.

(5) Since meteorological phenomena are always accompanied by more or less intense electrical manifestations, the importance in this respect of receivers of electric waves in wireless telegraphy is evident. The principle in itself, indeed, is not new, since in 1787 a priest, M. Ventan of Burki (near Basle), had invented a kind of harp with 15 strings of different thickness, over 90 metres long, stretched on large cylinders and arranged at suitable distances from each other. The instrument (meteorological harp) was placed in a north to south direction and inclined so as to form an angle of 20°–30° with the horizontal. During changes of weather the harp gave vibrations of various strengths according to the distance and magnitude of the depression which it indicated. The receivers of wireless telegraphy can pick up the so-called atmospheric "parasites" or disturbances, the intensity of which is variable and at present classified in three categories:—rustling, crackling, cracking. The crackings indicate the approach of a hurricane close to the station if the crackings increase in intensity and frequency; it is retreating if they decrease. Slight rustlings, similar to the sound of frying, indicate the coming of a hail cloud; numerous cracklings, on the other hand, are indications of the occurrence of a large depression. Rain and mist make reception fairly good; the contrary is the case when the air is dry and cold.

France: Vocational School for Shepherds at Rambouillet. — *The Bergerie Nationale* consists of an area of 250 hectares in the midst of the forest of Rambouillet and supports a pure-bred flock of Spanish merinos. The first animals of this flock (315 ewes and 41 rams) were imported from the province of Leon (Spain) as early as 1786, and the breed is considered as being one of the most important wool-producing breeds in the world. A large number of the progeny of the original flock have been exported and the breed has thus been established in all the continents. The flock at Rambouillet numbers 200 ewes and 200 rams of pure strain. These form three very hardy types, which show resistance to all conditions of feeding and to every difference of climate.

The school for shepherds, at present under the direction of Prof. A. E. Hilsont, was opened as long ago as 1874, but was closed in 1895 because the pupils, who were taken at the age of 12, were too young to gain any permanent benefit from it. It was re-opened in 1922. Pupils must now be at least 15 years old on entering, preference being given to those who have already completed their military service. The school is open from August until Christmas. The number of pupils may not exceed 15. This year the course will last ten months, so that the pupils may have practical experience in all the work connected with sheep-rearing, in shearing and in the slipping of lambs. Every day two hours and a half of theoretical instruction is given. The rest of the day is devoted to practical work among the Rambouillet merino sheep and the flocks for killing which Prof. Hillsont wishes to establish, and which include already the Dishley Merinos and Berrichons.

The course in sheep rearing is conducted by the director of the school himself, and includes the method of classification by points, feeding, the study of wool, animal husbandry, the building of sheep pens, a knowledge of sheep dogs and many other subjects. Another teacher gives lessons in veterinary medicine in its application to sheep; a third teaches French, geometry and a little arithmetic.

The head shepherd and his two assistants undertake the practical instruction. The other part, strictly zootechnical, also includes work in wood and iron and visits to breeding pens and slaughter houses in the neighbourhood. A com-

mittee of inspection undertakes the general improvement of the school. At the head of this is the Inspector General of Agriculture. It also includes a representative of the Colonial Department, a delegate of the Tourcoing Chamber of Commerce (one of the greatest centres of the wool industry in the north of France), and five sheep breeders from the five wool-producing districts of the country.

There is a museum attached to the school which contains samples of wool from all parts of the world, and in particular the collection of Rambouillet wool taken regularly from ewes and rams of from three to five years of age since 1786.—(*F. R. Arnold, La Vie Agricole et Rurale, Vol. XXVII, No.* 45. *Paris,* 1925.)

The Treatment of Flour with Chlorine Gas and by the "Golo" Process. *Neumann, M. P., and Kalming, H., Landwirtschaftliche Jahrbücher, Vol. LXI, No. E. Berlin,* 1925.—Among the measures suggested in recent years for the improvement of flour is that of treatment with chlorine gas, introduced about thirty years ago. The bleaching which results is due to the oxidation of the yellow colouring matter which is found in the fats of the flour. This method, however, is not common because it has certain drawbacks. It has now been replaced by the "Golo" process, in which 0·5 to 1·5 per cent. of nitrosyl chloride is added to the chlorine gas. The gaseous mixture to which is added a certain amount of air is passed into a receiver containing the flour, which is constantly shaken, and thus in a short time comes into close contact with the gas. The flour rapidly absorbs the gas. In concentrations of 0·015 to 0·02, which are considered normal, the flour retains no odour, nor can any traces of hydrochloric acid or of nitrous acid be found. Under the influence of the gas, the swelling capacity of the colloidal substance of the flour, especially of the albumen, increases. A greater capacity for water results and therefore a greater quantity of dough, which is more tenacious, softer and more susceptible of increase in volume during the process of bread making.

This action is due to increased acidity in the flour. With it also increases the solubility of the nitrogenous substances. If, however, these two factors increase beyond a certain point, as happens especially with soft wheats, the gas may have no effect, or it may even have a negative effect, as is the case when the action is too prolonged. The gas has no effect either on the keeping qualities of the flour or on the activity of the enzymes of the flour. Complete bleaching of the flour will result if the treatment is properly carried out, and the yellowish colour will disappear. If, on the other hand, the quantity of gas is excessive, the flour may take a greyish tone.

The action of the gas depends mainly on the accurate carrying out of the treatment, which may be considered as harmless on account of the very small quantity of gas used and the cleanly manner in which the process must be performed.

Italy: Measures for the Protection of Apiculture.—Under a decree law the formation of provincial consortia is being contemplated, consisting of owners of hives, supported if necessary by the Provincial Agricultural Councils, and in case of need made compulsory whenever apiculture has in any given province special importance. These consortia may in their turn be linked up with larger interprovincial consortia within the area of the same region. Their main work will be the supervision through specially appointed experts of all matters connected with the control of bee diseases and pests; the diffusion among agriculturists of the knowledge of the proper measures of control; the diffusion of the regional methods for bee-keeping, with special attention to the purity and careful selection of Ligurian bees; the protection of the economic interests of the apiculturists, of the trade and industry in bee-keeping, and the taking of steps to prevent frauds.

The decree law lays down regulations as regards prophylactic measures and the control of the infectious diseases of bees, ordering in case of need the destruction of hives and of infected utensils. No compensation is due to the apiculturists in respect of such destruction, but the consortia may guarantee a partial compensation payment under the form of insurance. A special article deals with the trade in honey, and in this connection provision is made for the taking of samples to establish purity by means of analysis.—(*Gazzetta Ufficiale, No.* 281, 1925.)

Union of South Africa: Promotion of the Agricultural Industries.—With this object certain fiscal charges have been introduced which, under certain conditions, shall be imposed on agricultural products, and the receipts from which shall be employed to promote: (*a*) experiments, enquiries, or the diffusion of agricultural information in respect of them; (*b*) the erection or purchase of buildings, lands, live stock, machinery, implements or requisites in view of the objects indicated in paragraph (*a*); (*c*) the most profitable method of sale of produce; (*d*) any other subsidiary to the purposes contemplated in paragraphs *a*, *b*, *c*; and finally (*e*) any further aid which in the opinion of the Minister of Agriculture is required for the advancement of agriculture.—(*The Union of South Africa Government Gazette Extraordinary*, *No.* 1489, 1925.)

Legislation with respect to the Importation and Exportation of Plants in Various States.—The Legislative Section of the International Institute of Agriculture sets forth by means of a short series of publications the current legislation passed in the various States for regulating the importation, exportation and transport of plants. Each monograph deals first with the legislative sources of the information in question, and then goes on to deal with the organisation of the national services responsible for the application of the measures in question.—(*Institut International d'Agriculture.*)

Spain: Stabilisation of the Grain Market.—The Ministry of Fomento, with the object of stabilising the national grain market, preventing speculation in grain and enabling farmers to keep it under normal conditions up to the time of the actual sale, authorised, in connection with the harvest of 1925, the making of loans to the farmers for an amount equal to half the value of the grain which they deposited in pledge. A sum of 50,000,000 pesetas was set aside for the purposes of these loans.—(*Gaceta de Madrid*, *No.* 188, 1925.)

Canada: Grain Legislation.—All trading questions relating to grain have been regulated in considerable detail by the Canadian Government in a law, consisting of 236 articles and divided into four parts, with the short title: "Canada Grain Act." A Board of Grain Commissioners is established which within thirty days of the close of the civil year must present a report to the Ministry of Commerce: (*a*) on all matters in connection with the inspection, weighing, storage and transportation of grain; (*b*) on such matters as the Ministry may direct. Under separate headings are set out the duties of inspectors, commercial grades, the grain standards board, the grain survey board; provisions relating to sales, to fees, weighmasters, offences, procedure, Eastern and Western Inspection Divisions, grain from the United States.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in June, July and August 1926.

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	JUNE.			JULY.			AUGUST.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
FAT STOCK:—									
CATTLE—	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w s. d.	per cwt. l.w. s. d.
Aberdeen-Angus ...	63 3	57 5	44 2	65 4	59 8	47 10	65 8	59 9	44 11
Cross-bred (Shorthorn)	59 11	53 11	38 11	61 11	56 3	41 10	60 10	54 7	39 6
Galloway	60 5	54 10	..	59 5	54 0	..	57 11	53 5	...
Ayrshire	58 10	51 5	36 5	59 9	51 3	37 3	60 6	51 6	39 6
Blue Grey	61 0	..	...	67 9	55 0	...	...	...	...
Highland	...	...	...	...	...	...	59 9	59 0	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb d.	per lb. d.	per lb. d.
VEAL CALVES	15¼	10½	6	13¾	10½	5¾	14	10¼	6
SHEEP—	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot	15½	14	11¼	14¼	13½	11	13¾	13½	10¼
Half-bred	15¼	13¾	9¾	14¼	13	8½	13¾	12¾	8½
Blackface	14½	13¼	10½	13¾	13	10¾	13¼	12½	10
Greyface	15	14	9½	14½	13½	9	14	13¼	8
Down Cross	15	13¾	...	14	13	...	13½	12¾	...
PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	14 9	13 8	...	14 8	13 8	...	14 6	13 6	.
Porkers	15 2	14 3	...	15 2	14 3	...	14 11	14 0	..

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND—*continued.*

Description.	June. 1st.	June. 2nd.	June. 3rd.	July. 1st.	July. 2nd.	July. 3rd.	August. 1st.	August. 2nd.	August. 3rd.
STORE STOCK:—									
CATTLE—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head	Per head.	Per head.
Aberdeen-Angus:	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	18 0	14 15	13 14	17 15	14 13	13 15	15 17	14 10	14 0
Two-year-olds ...	23 8	18 3	16 9	23 11	18 6	...	25 1	19 5	17 0
Cross-bred (Shorthorn):									
Yearlings	18 6	14 2	12 10	16 15	14 0	12 6	15 18	14 3	12 8
Two-year-olds ...	23 0	18 2	15 2	22 18	17 15	...	24 3	18 9	...
Galloway:									
Yearlings	16 16	...	...	15 13	...	...	16 8	...	...
Two-year-olds	24 0	...	...	24 15	21 0	...	..	21 0	...
Ayrshire:									
Yearlings	11 7	...	...	9 13	...	..	10 5	..	...
Two-year-olds ...	...	...	...	24 10	19 0	...	...	...	..
Blue Grey:									
Yearlings	...	..	.	..	.	...	...	..	...
Two-year-olds ...	...	...	...	...	...	...	...	...	...
Highland:									
Yearlings	12 13	10 19	9 3	12 0	9 16	7 5	...	...	...
Two-year-olds ...	17 10	15 15	14 0	15 7	13 3	11 0	..	...	...
Three-year-olds ...	21 15	19 10	16 5	19 5	...	...	...	...	...
DAIRY COWS—									
Ayrshire:									
In Milk	28 18	21 0	12 0	32 0	22 12	12 0	30 3	23 5	12 0
Calvers	28 1	21 14	14 8	29 16	22 2	14 10	29 8	22 8	14 13
Shorthorn Cross:									
In Milk	34 3	26 6	...	34 1	27 0	22 0	33 13	26 9	23 3
Calvers	31 13	23 4	17 1	32 7	23 7	17 2	33 5	24 4	18 2
SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ..	48 1	42 6	22 0	...	...	...	...	...	...
Half-bred Hoggs	69 4	57 4	51 4	67 11	...	...	...	...	..
Blackface Hoggs ..	47 0	34 8	32 0	32 6	26 1	...	38 0	28 2	...
Greyface Hoggs ...	54 9	45 1	38 0	55 0	42 3	...	53 10	44 9	...
Down Cross Hoggs	..	...	...	...	...	..	...	...	...
PIGS—									
(6 to 10 weeks old)	64 2	45 10	...	64 4	45 1	...	60 1	42 3	...

Average Prices of Dead Meat at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Quality.	June. Dundee.	June. Edinburgh.	June. Glasgow.	July. Dundee.	July. Edinburgh.	July. Glasgow.	August. Dundee.	August. Edinburgh.	August. Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
Beef :—										
Home-fed—										
Bullock or Heifer ...	1	8¾	9¾	10¾	9½	10⅜	10½	9⅝	10⅛	10¾
	2	8⅝	8⅞	9¾	9	8⅞	9½	9⅜	...	9¾
Bull	1	6⅞	7½	7½	7⅜	8⅛	7⅛	7½	7⅝	7⅞
	2	6⅝	7¼	6⅛	6⅞	7⅛	6⅝	7	7¼	6⅝
Cow	1	6¾	6½	7	7	6⅝	6⅞	6½	6⅛	7
	2	6⅛	...	5⅝	6	5	5⅜	6	...	5½
Irish—										
Bullock or Heifer ...	1	...	...	...	...	...	9⅜	...	...	9
	2	..	...	...	...	...	8⅜	...	...	8
Bull	1	..	...	...	...	...	6⅞	...	...	6⅞
	2	...	..	...	...	...	6	...	...	5⅞
United States & Canadian—										
Killed at Birkenhead ...	1	...	...	..	..	...	9¼	...	...	...
	2	...	...	...	...	...	...	...	...	...
Killed at Glasgow ...	1	...	...	8¾	...	...	9⅜	...	...	9
	2	...	...	8¼	...	...	8⅜	...	...	8
Argentine Frozen—										
Hind Quarters ..	1	6⅝	6⅛	...	6¼	6⅜	...	6⅛	6	...
	2	...	5½	...	..	6	...	5¾	5¾	...
Fore ,, ...	1	4⅝	4⅜	...	4⅜	4⅜	...	3⅞	3⅞	..
	2	...	...	...	...	4¼	...	3¾	...	...
Argentine Chilled—										
Hind Quarters ...	1	7⅞	7⅝	7⅜	6¾	6⅞	6⅞	7⅜	7½	7⅛
	2	...	7¼	7⅛	...	6½	6⅜	7⅛	7⅛	6¼
Fore ,, ...	1	4⅞	4⅝	4¾	3⅞	3⅞	3¾	4⅛	4¼	3⅞
	2	..	4⅜	4⅛	...	3⅝	3¼	3⅞	4⅛	3⅝
New Zealand Frozen—										
Hind Quarters ...	1	..	...	5⅝	...	...	5¾	...	..	5¾
Fore ,, ...	1	...	...	3½	...	...	3⅛	...	...	3
Mutton :—										
Hoggs, Blackface ...	under 60 lb.	13⅝	13¾	12⅞	14	12⅛	12	13	11⅜	11½
	60 lb. & over	12⅝	13½	11⅞	13	12	11⅜	...	...	11
,, Cross	under 60 lb.	13⅝	13¾	12⅞	14	12½	12	13	11⅜	11½
	60 lb. & over	12⅝	13½	11⅜	13	...	10⅞	...	...	10½
Ewes, Cheviot	1	11	8¼	10⅜	11	8⅜	9⅜	9⅜	7⅜	8⅛
	2	10	...	9⅜	10	...	8⅜	...	...	7⅛
,, Blackface ..	1	11	8¼	9⅞	11	8¼	8⅞	10	7½	7¾
	2	10	...	8¾	10	..	7⅞	..	...	6⅝
,, Cross	1	8⅜	7½	8⅞	8	7¾	7⅞	7½	7⅛	7⅛
	2	7⅜	...	7½	7	...	6⅜	...	...	6⅛
Argentine Frozen ...	1	...	...	6	..	...	5⅛	...	...	5⅛
	2	...	...	5	...	...	4⅛	...	...	4½
Australian ,, ...	1	...	5¾	...	...	5⅛	...	...	5½	...
	2	...	5⅜	..	...	5	...	...	5	...
Lamb :—										
Home-fed	1	16¼	17⅛	15	16	14½	13⅜	13½	13⅛	12⅜
	2	16	...	14	..	14	12⅜	...	10¾	11¼
New Zealand Frozen ...	1	...	11¼	10⅛	...	10⅛	9⅞	...	9⅜	9¼
	2	...	10⅛	9	...	9⅛	9	...	8⅛	8¼

AVERAGE PRICES OF PROVISIONS AT GLASGOW.

(Compiled from Reports received from the Board's Market Reporter.)

Description.	Quality.	June.	July.	August.
		s. d.	s. d.	s. d.
BUTTER:				
Irish Creamery per cwt.	1	171 7	166 6	170 0
	2	...	160 0	166 9
„ (Unsalted) „	1	174 6	171 0	175 0
Argentine ... ... „	1	...	...	...
„ (Unsalted) „	1	...	...	...
Australian ... ... „	1	178 5	176 6	175 0
Danish ... ... „	1	179 5	176 0	183 6
„ (Unsalted) ... „	1	184 5	181 6	189 6
Friesland (Unsalted)... „	1	178 0	169 0	178 3
New Zealand ... ... „	1	181 2	177 0	182 0
„ (Unsalted) „	1	183 2	179 0	184 0
Russian ... ... „	1	160 0	156 0	153 4
Swedish ... ... „	1	172 7	164 3	173 9
CHEESE:				
Cheddar ... ... „	1	91 10	90 9	90 0
	2	...	81 4	80 6
Cheddar Loaf ... ... „	1	98 0	97 0	96 6
	2	...	...	...
Dunlop... ... ... „	1	88 5	85 0	86 0
	2	...	80 0	78 6
Canadian ... ... „	1	115 10	93 4	91 3
	2	...	...	...
New Zealand (Coloured) „	1	99 6	94 9	90 0
	2	96 0	...	...
„ (White) „	1	99 6	96 9	92 6
	2	96 0	...	...
BACON:				
Ayrshire (Rolled) ... „	1	172 5	176 0	170 6
Irish (Green) ... ... „	1	164 0	159 0	154 0
„ (Dried or Smoked) „	1	174 0	169 0	164 0
„ (Long Clear) ... „	1	167 7	165 0	167 3
Wiltshire (Green) ... „	1	162 5	160 0	160 0
„ (Dried or Smoked) „	1	172 5	170 0	170 0

Description.	Quality.	June.	July.	August.
		s. d.	s. d.	s. d.
BACON—*contd.*				
American, Long Clear Middles (Green) per cwt.	1	132 6	130 0	130 6
„ Short Clear Backs „	1	123 6	125 6	125 0
„ Sides ... ... „	1	121 0	119 9	120 0
„ Cumberland Cut „	1	...	...	...
Canadian, Sides ... „	1	128 7	121 3	126 0
Danish, Sides ... ... „	1	136 7	130 0	139 0
HAMS:				
Irish (Smoked) per cwt.	1	232 0	232 0	232 0
	2	223 2	222 0	218 0
American, Long Cut (Green) ... ... „	1	143 0	146 0	148 6
American, Short Cut „	1	136 7	138 9	147 0
EGGS:				
Country ... per doz	1	1 2	1 5	2 0
	2	1 0	1 3	1 10
Irish ... ... per 120	1	12 2	13 0	17 6
	2	11 5	12 4	16 1
„ (Duck) ... „	1	11 0	10 10	13 5
	2	10 0	10 4	12 9
Belgian (Fresh) „	1	11 6	12 0	15 2
Danish ... ... „	1	13 2	16 0	16 11
	2	13 0	13 0	15 5
Dutch ... ... „	1	11 8	12 0	15 3
„ (Duck)... „	1	...	...	...
Egyptian ... „	1	...	...	...
	2	...	...	...
Polish ... ... „	1	8 10	8 10	11 8
	2	8 4	8 5	11 3
Swedish ... ,	1	13 0	13 0	15 11

AVERAGE PRICES OF FIRST QUALITY FRUIT AND VEGETABLES AT GLASGOW.

(*Compiled from Reports received from the Board's Market Reporter.*)

Description.	JUNE.	JULY.	AUGUST.
FRUIT :—			
Apples, *Imported* :	s. d.	s. d.	s. d.
Californian ... per case.*	...	...	15 0
Australian ... „	14 4	10 11	11 3
Currants, Black ... per lb.	...	1 0	1 1
„ Red ... „	...	0 6	0 6
Gooseberries, *Imported* „	0 2¼	0 2	0 2
„ *British* „	0 3	0 2½	0 2
Pears, French per box of 48.	...	...	3 9
„ Californian ... per case.**	...	...	14 0
Plums, Egg ... ... per lb.	...	...	0 2
„ Prolific ... „	...	...	0 3
„ Monarch ... „	..	...	0 4
„ Victoria ... „	..	...	0 5
Raspberries ... ... „	...	1 0	1 0
Strawberries, *English* „	0 10	...	...
„ *Scotch* „	...	0 7	...
VEGETABLES :—			
Beet ... ... per cwt.	7 0	7 0	8 0
Cabbages—			
Coleworts ... ... per doz.	1 8	1 11	1 7
Carrots, *British* per doz. bunches.	5 2	3 8	10 9§
Cauliflowers, *British* per doz.	5 2	4 5	4 6
Cucumbers ... ... „	4 8	4 0	6 0
Lettuce, Cos. ... „	1 5	1 3	1 2
„ Cabbage ... „	1 8	1 3	1 2
Onions—			
Valencia ... ... per case.†	10 8	11 0	13 0
Egyptian ... . per bag.‡	11 4	12 6	...
Spring ... ... per bunch.	0 4	0 6	0 5
Parsley ... ... per cwt.	41 7	24 0	19 0
Peas, Home-grown ... „	...	18 6	14 0
Rhubarb ... ... „	12 10	9 6	8 0
Tomatoes, *British* ... per lb.	0 9¼	0 8½	0 6
„ *Channel Islands* „	0 8¼	0 6¼	0 4
Turnips ... per doz. bunches.	4 4	4 2	3 6
Vegetable Marrow ... per doz	...	...	3 6

* 40 lb. (approx.). ** 20 lb. † 9 stone (approx.).
‡ 8 stone (approx.). § per cwt.

Average Prices of Potatoes at Dundee, Edinburgh, and Glasgow.

(*Compiled from Reports received from the Board's Market Reporters.*)

Market.	Quality.	First Earlies.	Second Earlies.	Late Varieties. Red Soils. Langworthy and Golden Wonder.	Late Varieties. Red Soils. Other.	Late Varieties. Other Soils. Langworthy and Golden Wonder.	Late Varieties. Other Soils. Other.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
June.							
Dundee per ton.	I	...	...	...	...	4 10 0	3 10 0
Edinburgh ,,	I	10 0 0	...	...	...	...	4 0 0
Glasgow ,,	I	10 5 0	...	6 13 0	...	6 2 0	4 9 0
July.							
Dundee ,,	I	6 13 0	..	...	...	...	...
Edinburgh ,,	I	6 15 0	...	...	...	...	...
Glasgow ,,	I	6 4 0	...	...	...	...	...
August.							
Dundee ,,	I	3 15 0	3 0 0	...	...	...	...
Edinburgh ,,	I	4 2 6	...	...	...	...	...
Glasgow ,,	I	3 12 2	4 8 4	...	...	...	...

Average Prices of Roots, Hay, Straw, and Moss Litter, at Dundee, Edinburgh, and Glasgow.

(*Compiled from Reports received from the Board's Market Reporters.*)

Market.	Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley.	Straw. Oat.	Moss Litter.
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
June.										
† Dundee ... per ton.	I	...		22 0	145 0 (*a*) 128 0 (*b*)	...	88 6	88 6	94 0	51 0
‡ Edinburgh ,,	I	.		...	139 0 (*a*) 135 0 (*b*)	..	92 0	83 6	94 0	39 0
‖ Glasgow ,,	I	...	...	...	100 0	105 0	75 0	..	85 0	37 6
July.										
† Dundee ... ,,	I	...	...	...	145 0 (*a*) 130 0 (*b*)	...	90 0	90 0	96 3	51 0
‡ Edinburgh ,,	I	...	...		140 0 (*a*) 135 0 (*b*)	. .	95 0	85 0	95 0	39 0
‖ Glasgow ,,	I	...	...	...	98 9	103 9	76 3	...	85 0	37 6
August.										
† Dundee ... ,,	I	...	...	...	145 0 (*a*)	...	90 0	90 0	91 3	51 0
‡ Edinburgh ,,	I	...	..	...	140 0 (*a*)	...	95 0	85 0	95 0	39 0
‖ Glasgow ,,	I	...	...	...	83 9	92 6	83 9	...	81 3	37 6

† Quotations for Straw, baled and delivered.
‡ ,, ,, delivered loose in town.
‖ ,, baled Hay and Straw f.o.r.

(*a*) Baled and delivered.
(*b*) Delivered loose.

Average Prices of Feeding Stuffs at Glasgow and Leith.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	June.		July.		August.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	11 2 0	10 11 0	11 7 6	10 12 6	11 10 0	11 2 6
Foreign	11 9 0	...	11 1 11	10 5 0	10 15 0	10 5 0
Decorticated Cotton Cake	10 0 6	...	10 16 3	...	...	...
Undecorticated Cotton Cake—						
Bombay (Home-manufactured)...	...	5 15 0	...	5 7 6	...	5 10 0
Egyptian (Home-manufactured)...	6 7 6	6 2 6	6 5 0	5 19 2	6 5 0	...
Palmnut Kernel Cake	6 19 6	..	7 12 6	...	8 5 0	...
Coconut Cake ...	9 15 0	...	...	...	10 15 0	...
Groundnut Cake— Undecorticated	*7 15 0 **7 19 0	... **7 13 0	*7 15 0 **7 18 2	... **7 15 0	*7 11 8 **7 15 8	... **7 15 0
Maize Germ Cake—						
Home	9 12 0	..	9 15 0	...	...	...
Foreign	9 3 0	...	9 7 6	...	9 5 0	...
Maize Germ Cake Meal	9 16 8	...	10 10 0	...	...	...
Bean Meal	11 19 0	11 14 0	12 6 3	11 10 0	12 17 6	12 0 0
Maize Meal—						
Home Manufactured	9 4 0	8 15 0	9 5 8	8 14 5	9 13 2	8 12 6
South African Yellow	8 6 6	8 3 0	8 9 5	8 5 0	8 14 5	8 12 6
South African White	8 3 0	...	8 2 6	...	8 11 11	...
Rice Meal	6 10 6	...	6 5 0	...	6 10 0	...
Locust Bean Meal ...	9 0 0	8 15 0	8 16 8	8 12 6	...	8 7 6
Locust Beans (Kibbled and Stoned)	...	7 17 0	...	7 13 9	...	7 10 0
Maize Gluten Feed (Paisley) ...	8 2 0	...	8 5 0	...	8 10 0	...
Maize ...	†8 7 0 ‡8 3 9	7 13 0 ...	†8 8 9 ‡8 4 5	7 16 11 ...	†8 9 2 ‡8 10 0	8 2 6 ...
Oats, Canadian—						
(No. 2 Feeds)	9 3 0	...	8 15 8	...	9 0 0	...
,, Plate	8 5 0	...	8 8 2	...	8 3 2	...
,, Home ...	10 10 0	9 14 0	10 10 0	9 12 6	10 0 0	9 15 0
Barley (Feeding) ...	9 5 0	9 4 0	9 10 0	9 12 6	9 0 10	9 10 0
Barley (Bran) ..	9 1 0	...	9 1 3	..	8 5 0	...
Malt Culms... ...	6 17 0	6 0 0	6 13 9	...	6 5 0	...
Distillery Mixed Grains—Dried	8 6 0	9 3 0	7 18 9	8 18 9	8 0 0	8 5 0
Brewers' Grains—Dried	7 15 0	8 2 0	7 15 0	7 13 2	7 11 3	6 12 3
Distillery Malt Grains—Dried ...	7 10 6	...	7 15 8	...	7 10 0	...
Wheat—						
Middlings (Fine Thirds or Parings)	8 5 5	7 1 6	8 13 8	6 19 5	9 12 6	7 12 6
Sharps (Common Thirds) ...	6 6 6	6 11 0	6 5 0	6 3 9	6 12 6	6 2 6
Bran (Medium) ...	6 1 0	5 19 0	6 1 11	5 15 0	6 5 8	5 17 6
,, (Broad) ...	6 4 6	6 18 6	6 6 11	6 12 6	6 10 0	6 13 9
Feeding Treacle ..	6 15 0	7 0 0	6 12 6	6 16 3	6 10 0	6 10 0
Crushed Linseed ...	25 2 0	...	24 10 0	...	...	...
Fish Meal	18 19 0	18 2 0	18 17 6	18 0 0	...	17 10 0
Beans—						
China	11 5 0	...	11 6 3	...	...	...
English	12 12 0	...	12 18 2	...	...	...
Sicilian	11 5 0	...	11 6 3	...	11 11 8	...

* 37 per cent. Oil and Albuminoids.
** 40 per cent. Oil and Albuminoids.
† Plate.
‡ American, No. 2 Mixed.

Average Prices of Fertilisers at Glasgow and Leith.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Guaranteed Analysis.	June. Glasgow.	June. Leith.	July. Glasgow.	July. Leith.	August. Glasgow.	August. Leith.
	%	per ton. £ s. d.	per ton. £ s. d.	per ton £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Nitrate of Soda ...	N. 15½	13 10 0	13 5 0	13 0 0	13 5 0	13 0 0	13 2 6
Nitrate of Lime ...	N. 13	11 15 0		11 15 0	...	11 15 0	...
Sulphate of Ammonia (Neutral and Granular) ..	N. 21	13 1 0	13 1 0	13 1 0	...	13 1 0	...
Superphosphate ...	S.P. 30	3 2 6	3 2 6	2 10 0	..	2 10 0	..
,,	S.P. 35	3 7 6	3 7 6	2 15 0	..	2 15 0	...
,,	S.P. 38	3 12 6	3 12 6	3 0 0	..	3 0 0	...
Bone Meal - Home	N. 5 / I.P. 40	8 0 0	...	.	...	..	...
,, ,, ,,	N. 3¾ / I.P. 49	...	8 0 0	...	..	...	..
,, ,, —Indian	N. 3¾ / I.P. 49	..	8 5 0	...	..	..	...
,, ,, ,,	N. 3¾ / I.P. 45	...	.	8 15 0	...	8 15 0	...
Steamed Bone Flour	N. 1 / I.P. 60	7 10 0	6 0 0	6 10 0	...	6 10 0	...
Basic Slag	T.P. 22	*2 4 6	...	*2 4 6	.	*2 4 6	...
,, ,, ...	,, 24	*2 7 6	.	*2 7 6	...	*2 7 6	...
,, ,, ...	,, 26	*2 11 6	**2 13 6	*2 11 6	...	*2 11 6	...
,, ,, ...	,, 28	*2 15 0	**2 15 0	*2 15 0	...	*2 15 0	...
,, ,, ...	,, 30	*3 0 0	**2 17 0	*3 0 0	...	*3 0 0	...
,, ,, ...	,, 32	...	...	*3 4 0	...	*3 4 0	...
,, ,, ...	,, 40	...	†3 5 0	...	...	...	...
Sulphate of Potash (on basis of 90 per cent. sulphate of potash)	Potash 48·6	10 2 6		10 2 6	..	10 2 6	..
Sulphate of Potash	,, 50	...	10 2 6	...	...	...	...
Muriate of Potash .. (on basis of 80 per cent. sulphate of potash)	,, 50	8 5 6	8 0 6	8 5 6	...	8 5 6	...
Potash Salts ...	,, 20	3 2 6	3 1 0	3 2 6	...	3 2 6	...
,, ,, .	,, 30	4 8 0	4 8 0	4 8 0	..	4 8 0	...
Kainit—In bags ...	,, 14	2 15 6	2 14 0	2 15 6	...	2 15 6	...
,, —In bulk ..	,, 14	.	.	...	...	...	..
Ground Mineral Phosphate— Finely ground ...	I.P. 60	2 10 0		2 10 0	...	2 10 0	...
North African ...	I.P. 56	...	2 5 0	...	.	...	...

Abbreviations:—N. = nitrogen; S.P. = soluble phosphate; I.P. = insoluble phosphate; T.P. = total phosphate.

* Carriage paid (4-ton lots) to Ayrshire and Renfrewshire; quotations for delivery in Lanarkshire 2s. per ton higher.

** English Slag, carriage paid to stations in the Lothians. † Belgian Slag, at Leith.

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